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LIGHT EMITTING DIODES FOR FIBER OPTIC COMMUNICATIONS.(U)
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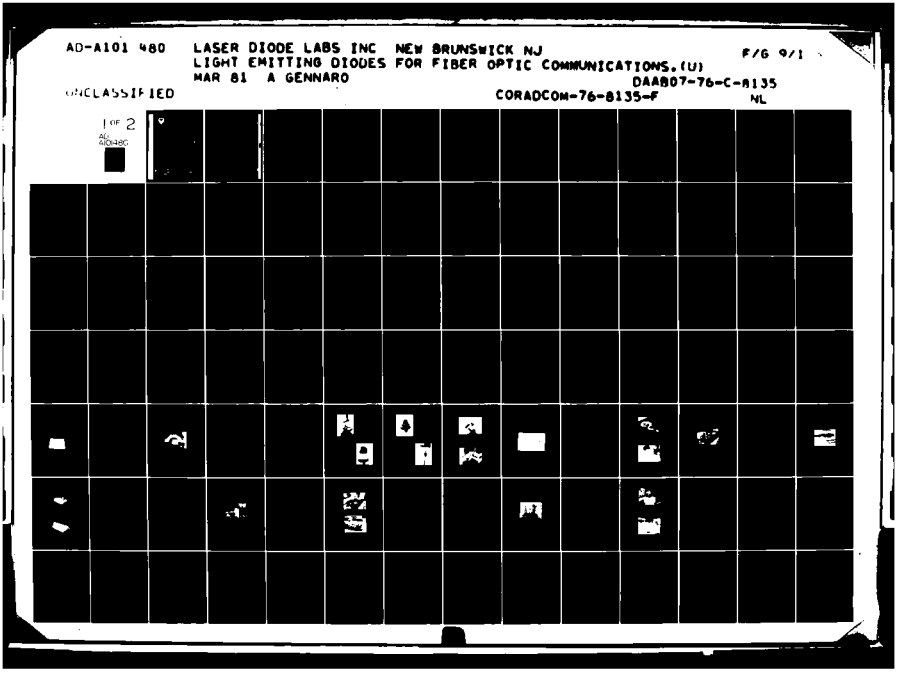

LEVEL II

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RESEARCH AND DEVELOPMENT TECHNICAL REPORT
CORADCOM-76-8135-F

LIGHT EMITTING DIODES FOR FIBER OPTIC COMMUNICATIONS

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31 MARCH 1981

FINAL REPORT FOR PERIOD SEPTEMBER 1976-FEBRUARY 1981

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REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: CORADCOM-76-8135-F	2. GOVT ACCESSION NO: AD-A101 480	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Light Emitting Diodes for Fiber Optic Communications,	5. TYPE OF REPORT & PERIOD COVERED: Final Report 9/30/76 - 2/28/81
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Albert Gennaro	8. CONTRACT OR GRANT NUMBER(s): DAAB07-76-C-8135
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Laser Diode Laboratories, 1130 Somerset Street, New Brunswick, N. J. 08901	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S.A. CORADCOM, Ft. Monmouth, N. J. 07703, Attn: DRDCO-PC-D(HUN)	12. REPORT DATE: March 31, 1981
	13. NUMBER OF PAGES: 154
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Light Emitting Diode
Fiber Optic Communications
Gallium Aluminum Arsenide
Double Heterojunction LED

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The design and fabrication of high speed etched-well emitting diodes for fiber optic communications is discussed with regard to material synthesis via LPE, wafer fabrication, and device assembly in a manufacturing environment.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION I

INTRODUCTION

The primary objective of this Manufacturing Methods and Technology Engineeering Program is twofold. First, the manufacturing methods and techniques necessary for the volume production of the light emitting diode for use in fiber optic communications as outlined in Specification SCS-511 must be developed and implemented to insure the highest degree of device quality and reliability at a reasonable cost. Secondly, verification of device performance and quality for LED's produced in a volume manufacturing environment must be carried out by means of rigorous testing and evaluation in accordance with SCS-511 in order to demonstrate the technical adequacy of the manufacturing methods developed under this contract.

This report describes the techniques and methods used to attain the goals as described above. In particular laser chip concepts and design, package concepts and design, and environmental and electrical testing were key areas and established the emphasis required to achieve the successful completion of the program. The major program objectives include development of the epitaxial process, a coaxial package configuration with fiber pigtail,

the assembly process and test equipment for parameter testing, Burn-in, and life testing of completed devices.

SECTION II

DEVICE DESIGN REQUIREMENTS AND PERFORMANCE SPECIFICATIONS

2.1 Electro-Optical Characteristics.

The performance characteristics of the Light Emitting Diode for Use in Fiber Optic Communications are described in detail in Technical Specification SCS-511. The device may be generally described as a double-heterojunction (DH) GaAs - GaAlAs etched well incoherent emitter capable of high data rate transmission optimized for an emitting wavelength of 820 nm at room temperature. In addition, a fiber optic pigtail is incorporated into the device in order to permit coupling to the optical link via fiber splicing. An outline of the major electro-optical performance characteristics of the device is shown in Table 1. Table 2 lists the optical characteristics of the fiber pigtail. A more detailed description of the device, including environmental performance and parameter test methods can be found in SCS-511.

2.2 Device Structure

To achieve the electro-optical characteristics outlined in Table 1, a double heterojunction (DH), GaAs-GaAlAs structure having a very thick transparent window layer is employed.

TABLE I - PROGRAM GOALS

TEST	CONDITIONS MIL-STD	METHOD	REQUIREMENTS
Subgroup 1			
Visual & Mechanical	750	2071	-
Terminal Strength (Pull)	750	2036A	10 Newtons min.
Subgroup 2	END POINT TESTS		
Peak Wavelength	845±45nm		
V_F	750	4011	1.9V@I_F=100mA max
V_{op}	750	4021	3.0V@I_F=10mA min.
Output Power 25°C	75uW @ I_F = 100mA min.		
Subgroup 3			
Spectral Width	50nm @ 3db of intensity (max)		
Bandwidth	32MH$_z$ @ I_p = ±50mA + 100mA DC bias		
Numerical Aperture	0.2 @ I_F = 100mA		
Rise & Fall Time	20ns @ I_p = 100mA, + 5mA bias (max)		
Linearity	26db @ I_p = ±50mA, + 100mA dc bias		

TABLE 2 - FIBER CHARACTERISTICS

ITT T-202 GRADED INDEX

Attenuation (8200 Å)	8db/KM
Core Diameter	55 μm
Cladding Diameter	125 μm
Jacket Diameter	500 μm
Numerical Aperture (N.A.)	.25
Tensile Strength	10 Newtons
Bending Radius	.5CM

Details of the epitaxial structure required for the production of the etched well emitter are shown in Figure 1. The substrate, region 1, is n-type GaAs doped with Si to $2x10^{18}/cm^3$ with an EPD < $1K/cm^2$. Region 2 consists of an n-type $Ga_{.7}Al_{.3}As$ window layer through which light generated by the injection of carriers into the lower bandgap active region 3, is coupled to the optical fiber. The low absorption coefficient of the n-type GaAlAs window layer renders it transparent to the 820nm emission from the active region. The bandgap of the $Ga_{.94}Al_{.06}AS$ active region, hence the aluminum concentration, determines the peak emission wavelength of the LED. Maximum power efficiency and minimum risetime occur when the active region is doped $\approx 1x10^{18}$ with Ge as indicated by the curves in Figure 2. Region 4, a p-type $Ga_{.7}Al_{.3}As$ layer, serves to confine carriers injected into the active region by virtue of its increased bandgap. Region 5 functions as a contact cap. Aluminum is incorporated in this p-type layer to minimize lateral current flow by increasing its resistivity.

The diameter of the emitting surface is determined primarily by the diameter of the circular contact applied to the surface of region 5 and the sheet resistivities of regions 4 and 5. As shown in Figure 3 by the dashed lines, current is restricted to flow through the active region directly under the circular aperture which has been selectively metallized. To facilitate selective

Epitaxial Structure

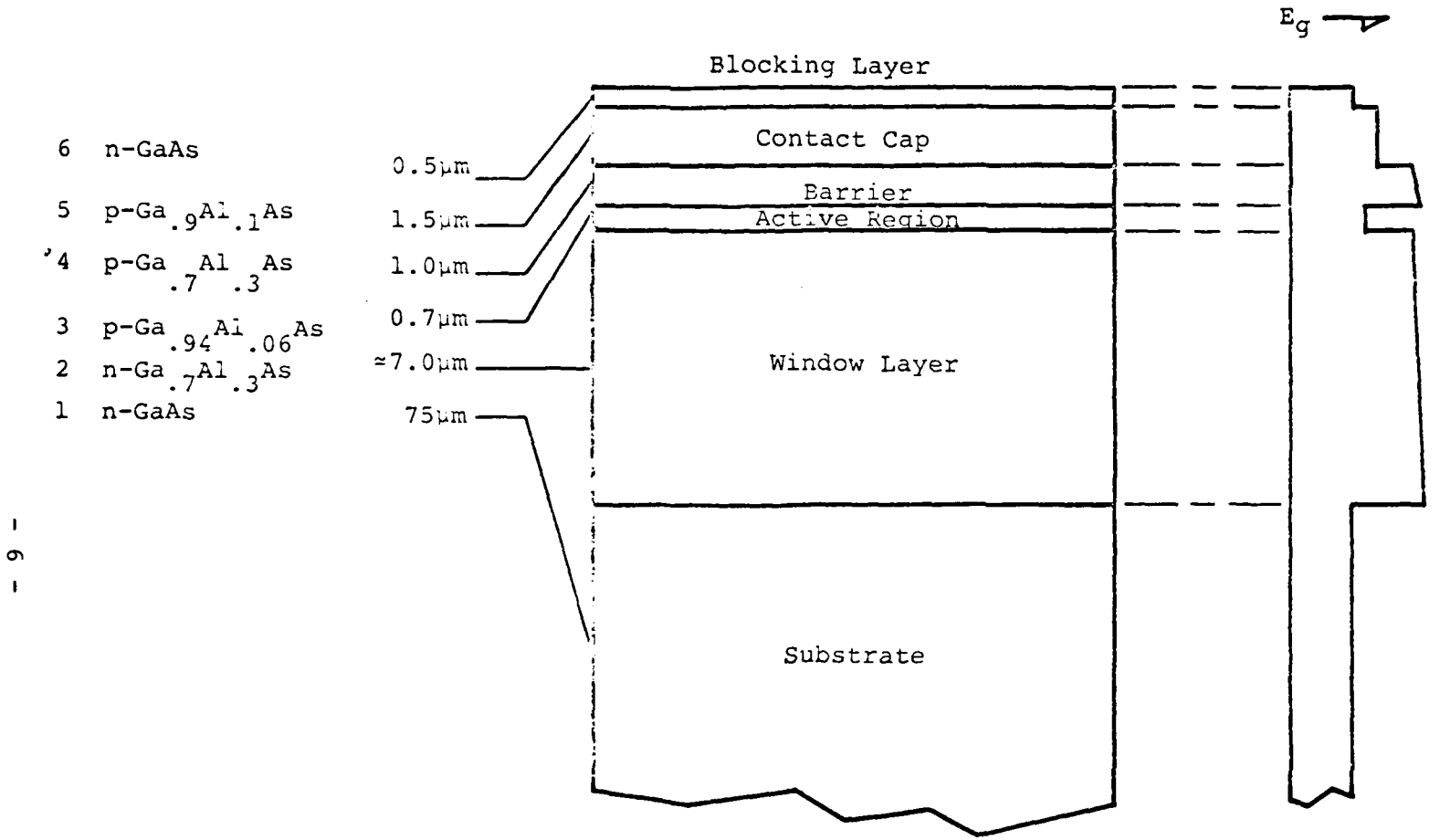


Figure 1 - Schematic Representation of Double Heterojunction Epitaxial Structure for Use in the Fabrication of the Fiber Optic Coupled LED.

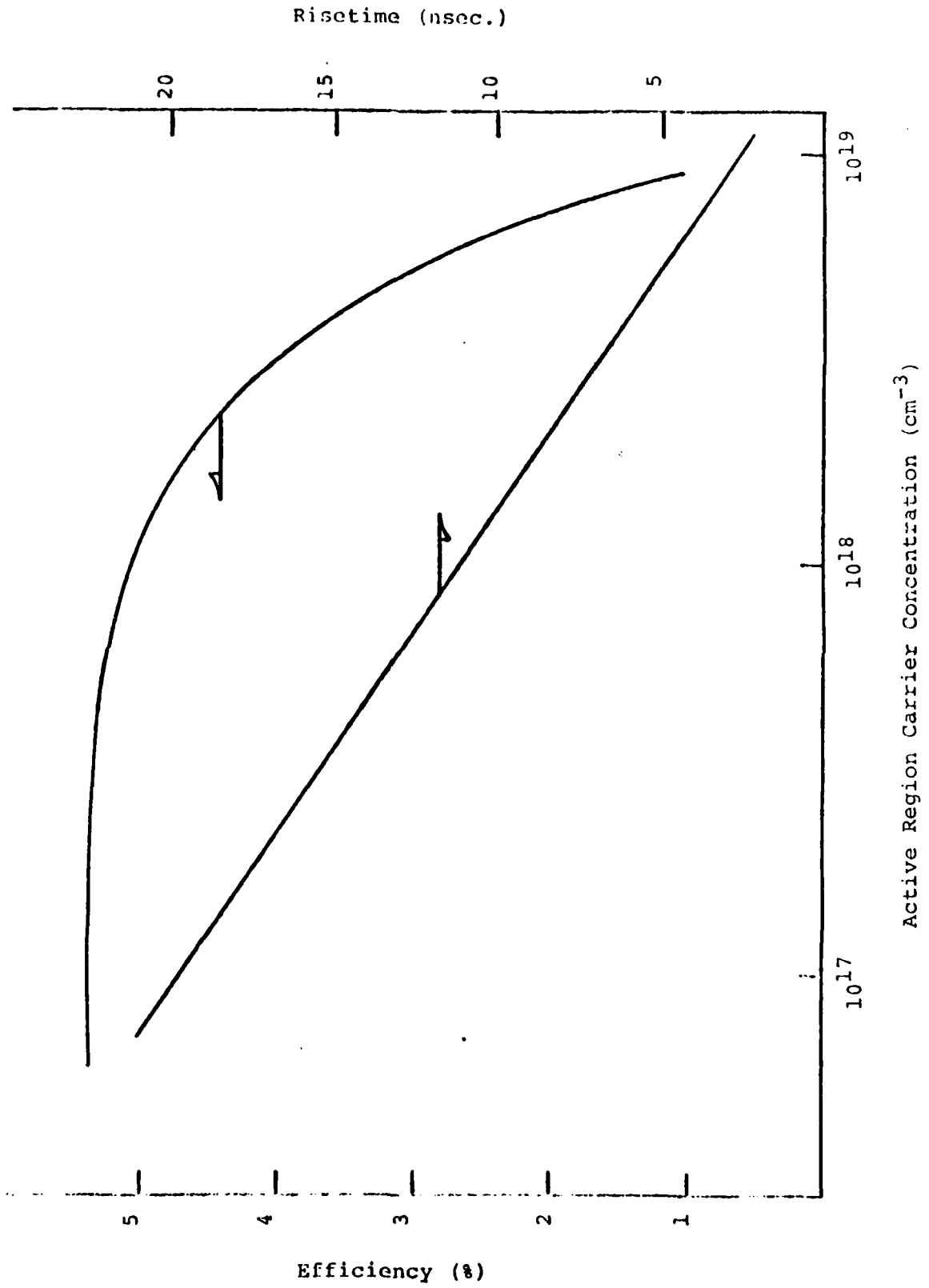


Figure 2 - Power Efficiency and Risetime vs. Active Region Doping Level for Germanium Doped LEDS.

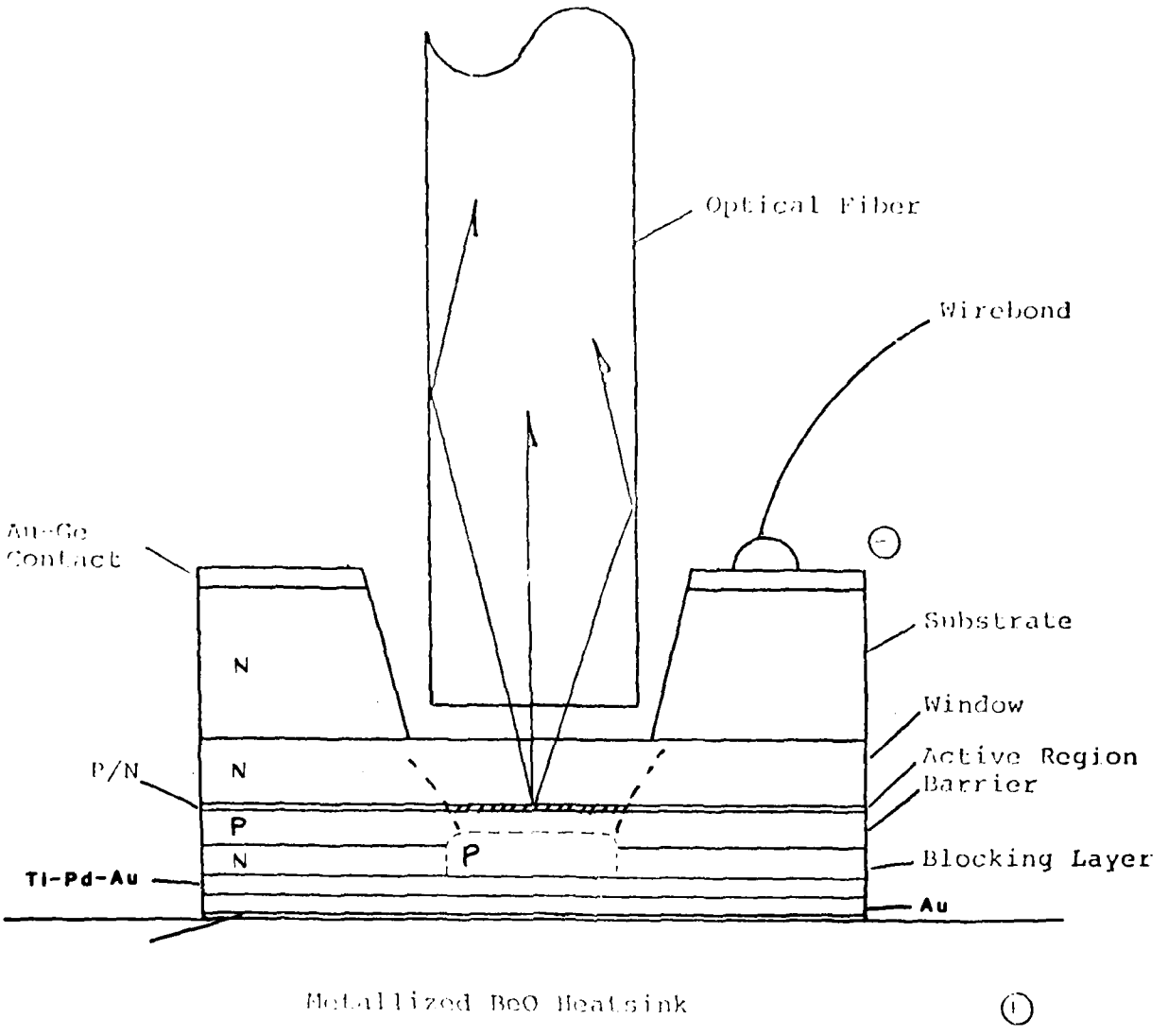


Figure 3 - Chip Configuration for the Manufacture of High Radiance High Speed Fiber Coupled Light Emitting Diodes.

contacting, a 40μm hole is etched through region 6, an n-type GaAs current blocking layer. Under forward bias conditions, the P-N junction formed at the interface between region 5 and 6 is reversed biased allowing current to flow only in the region directly below the 40μm ohmic contact. Light generated in the active region directly above this circular aperture passes through the transparent window layer and is emitted from the bottom surface of the etched well as shown in Figure 3.

2.3 Package Requirements

Technical Specification, SCS-511, defines the outline package drawing for the etched well light emitting diode. The package is based upon a dual stripline stud configuration and has been modified to accept an optical fiber pigtail.

SECTION III

MANUFACTURING METHODS AND TECHNOLOGY ENGINEERING

3.1 Materials Technology.

3.1.1 Synthesis of Device Structure via LPE.

3.1.1.1 Liquid Phase Epitaxial System.

Liquid phase epitaxy is a complex process in which single crystal layers of semiconductor material are deposited on a single crystal substrate of lattice matched material by precisely controlled cooling of a saturated solution in contact with the substrate. In the case of hetero-epitaxial synthesis of GaAs and GaAlAs layers for LED

fabrication, gallium (Ga) is the preferred solvent and the substrate is normally high quality, low Etch Pit Density, (100)GaAs.

Crystal growth of these structures takes place at temperatures ranging between 750°C and 900°C and must be performed in an inert or reducing atmosphere to avoid the highly detrimental effects of oxygen contamination. The properly designed LPE reactor and support systems must satisfy several criteria in order to yield epitaxial wafers suitable for fabricating double heterojunction geometry LED structures. These criteria are dictated by the uniformity, reliability, and produceability requirements of semiconductor optoelectronic components for volume commercial manufacture. Maximum surface area, layer thickness uniformity, compositional uniformity, and minimum defect density are required. In addition, the as-grown surface morphology of the terminal layer must be compatible with photolithographic processing for the definition and patterning of stripe geometry contacts. Figure 4 shows a block diagram of the epitaxial system in use at Laser Diode Laboratories. This system incorporates several features which have resulted in the optimization of the liquid phase process:

Isothermal Heat Pipe Furnace: The sodium filled isothermal liner eliminates all vertical and horizontal temperature gradients and, hence provides uniform

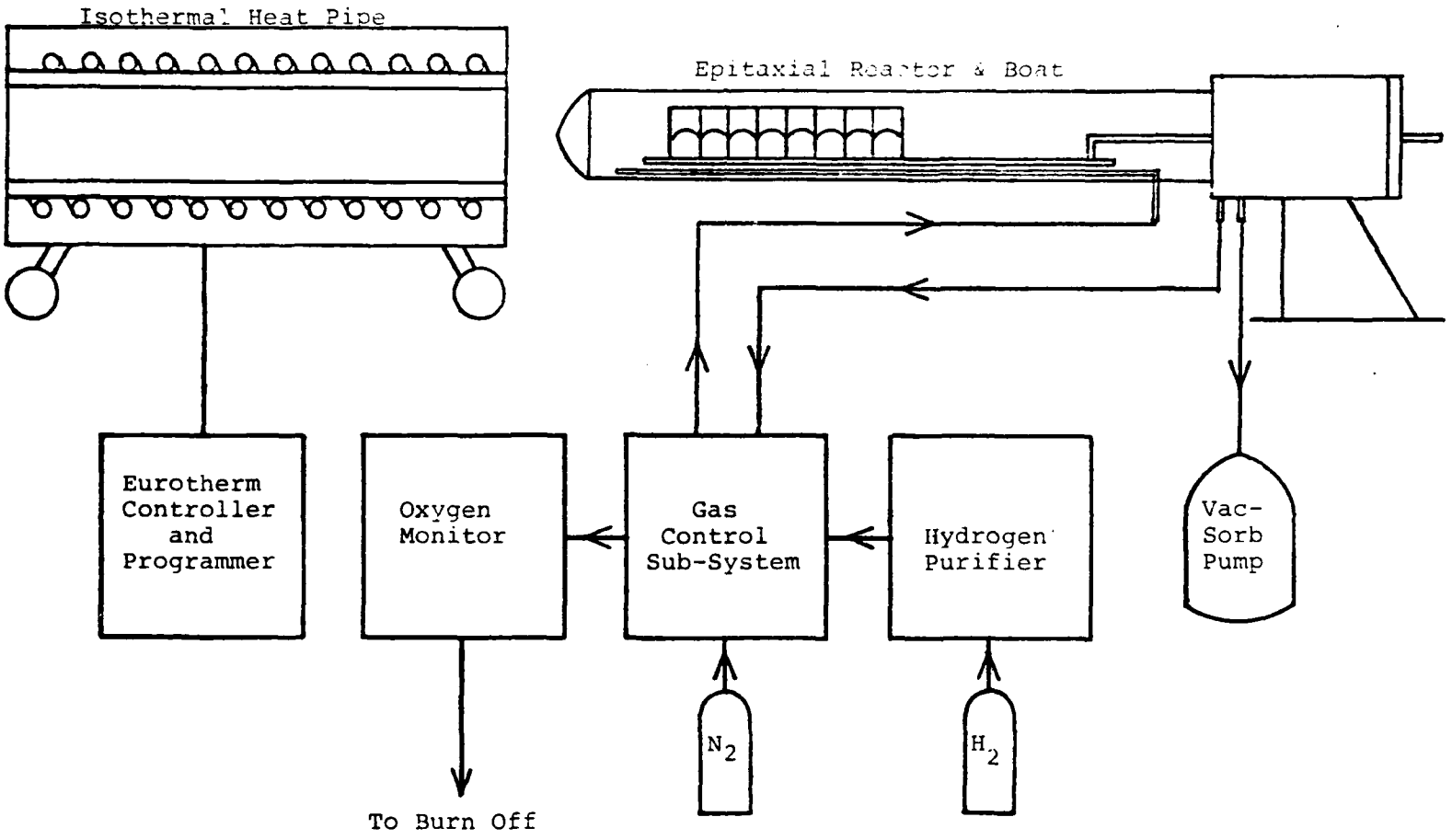


Figure 4 - Block Diagram of Liquid Phase Epitaxial Systems Currently in Use at Laser Diode Laboratories.

deposition rates over the entire surface of the substrate. The isothermal liner also allows the use of large epitaxial boats, therefore, larger epitaxial wafers can be synthesized or more complex structures can be grown.

Vac Sorb Pump: The use of a molecular sieve prior to the start of the run completely removes all traces of oxygen from the growth ambient without the risk of organic contamination.

Oxygen Monitor: The use of a fuel cell apparatus in the output stream of the system allows continuous monitoring of the O_2 content of the system both prior to and during epitaxial synthesis. This apparatus assures system integrity resulting in reproducible growth rates, alloy composition, and defect free growth by preventing the formation of Al_2O_3 in the melt.

In addition to obtaining optimum system performance through improved design concepts, the design and construction of the epitaxial boat is crucial to obtaining high quality hetero-epitaxial material. The ultra high purity, high density graphite boat is shown in the photograph of Figure 5. The eight bin boat utilizes a built-in indexing mechanism for accurate positioning of the substrate in each bin. Also an extra bin is employed to remove excess gallium which may adhere to the surface of the wafer as it is removed from the final melt.

Together, the modified epitaxial reactor and epitaxial

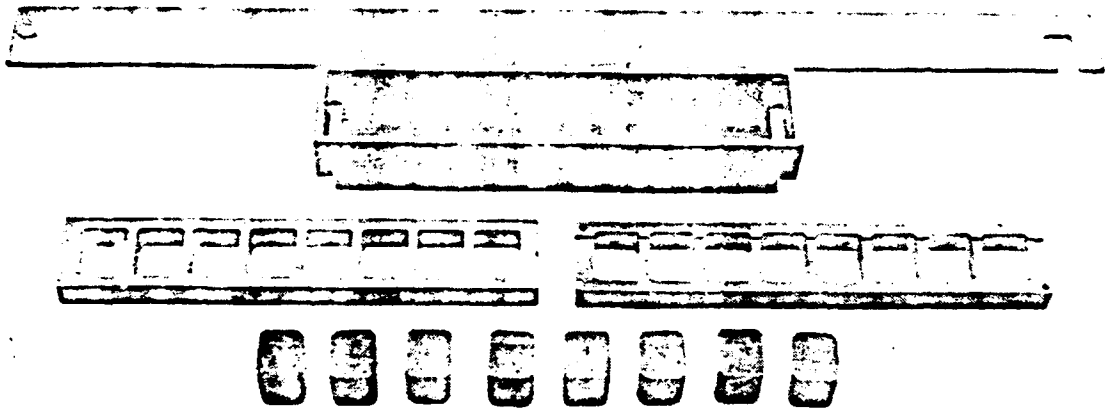


Figure 5 - Photograph of Eight Bin Ultra High Purity Graphite Epitaxial Boat.

boat allow the generation of double heterojunction structures in a manufacturing environment for the volume production of etched well light emitting diodes for fiber optic communications.

3.1.1.2 Growth Process for the Synthesis of the Double Heterojunction Structure.

Epitaxial synthesis of the double heterojunction structure is accomplished according to the sequence of events outlined in the flow chart of Figure 6. Table 3 lists the melt compositions for the growth of the double heterojunction structure used in the fabrication of the light emitting diode. After the appropriate melt ingredients, gallium (Ga) charges, and polycrystalline source wafers, have been loaded into consecutive growth bins, the single crystal (100) GaAs substrate is placed into the slider well of the high purity graphite boat. A graphite cover plate is employed to eliminate surface dissociation of the substrate during equilibration. The boat is then loaded into the quartz growth tube and the system is evacuated by means of the Vac-Sorb pump. Following a short H_2 purge, the system is brought up to the starting temperature of 850°C by rolling the isothermal liner into the growth position. Melt saturation is accomplished during a one hour soak at 850°C during which time enough GaAs is dissolved from the source wafers in order to exactly saturate each melt. This recently developed self-saturation scheme has simplified the growth procedure by eliminating the

Figure 6 - Sequence of Operations for Liquid Phase Epitaxial Synthesis.

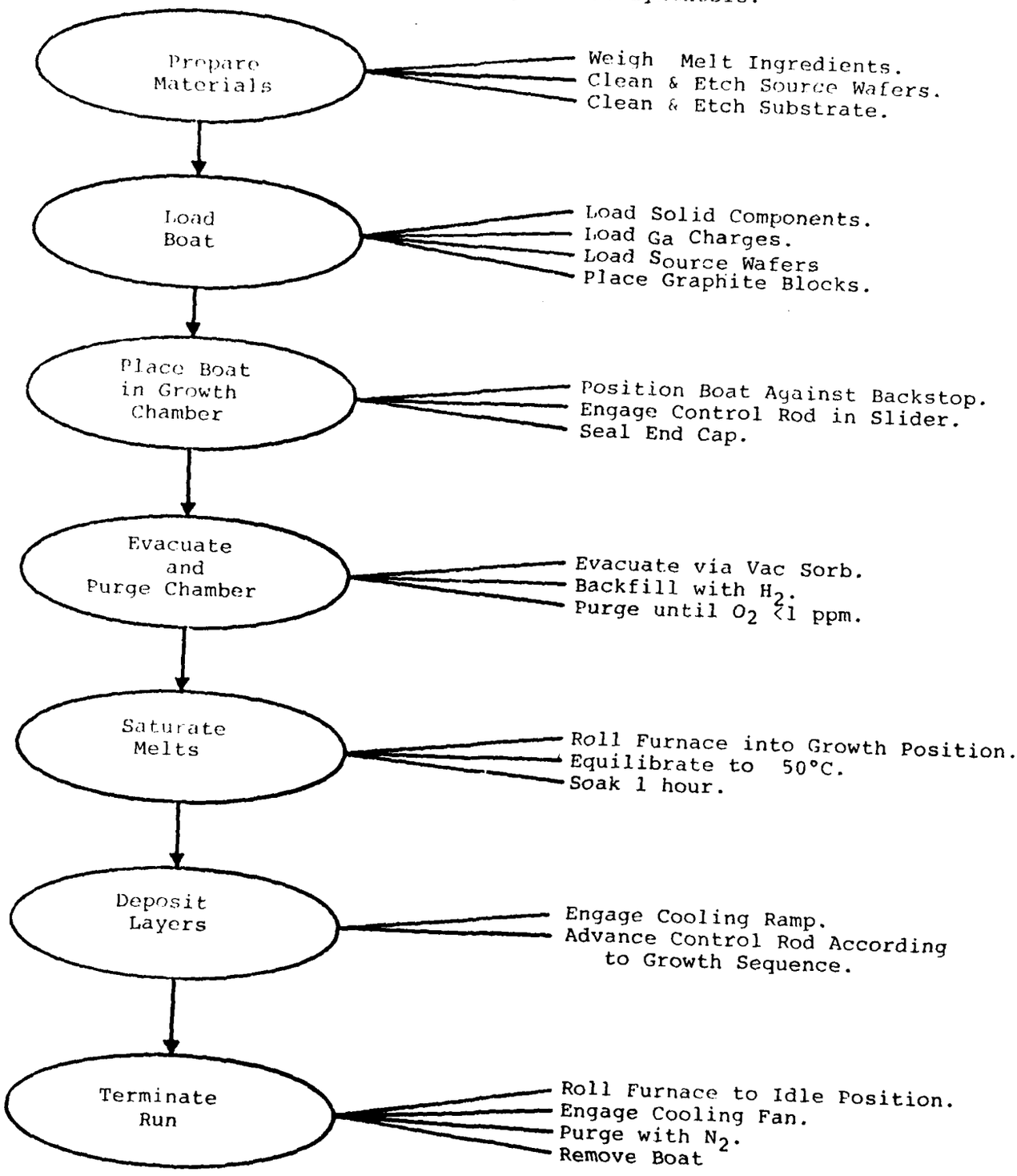


TABLE 3.

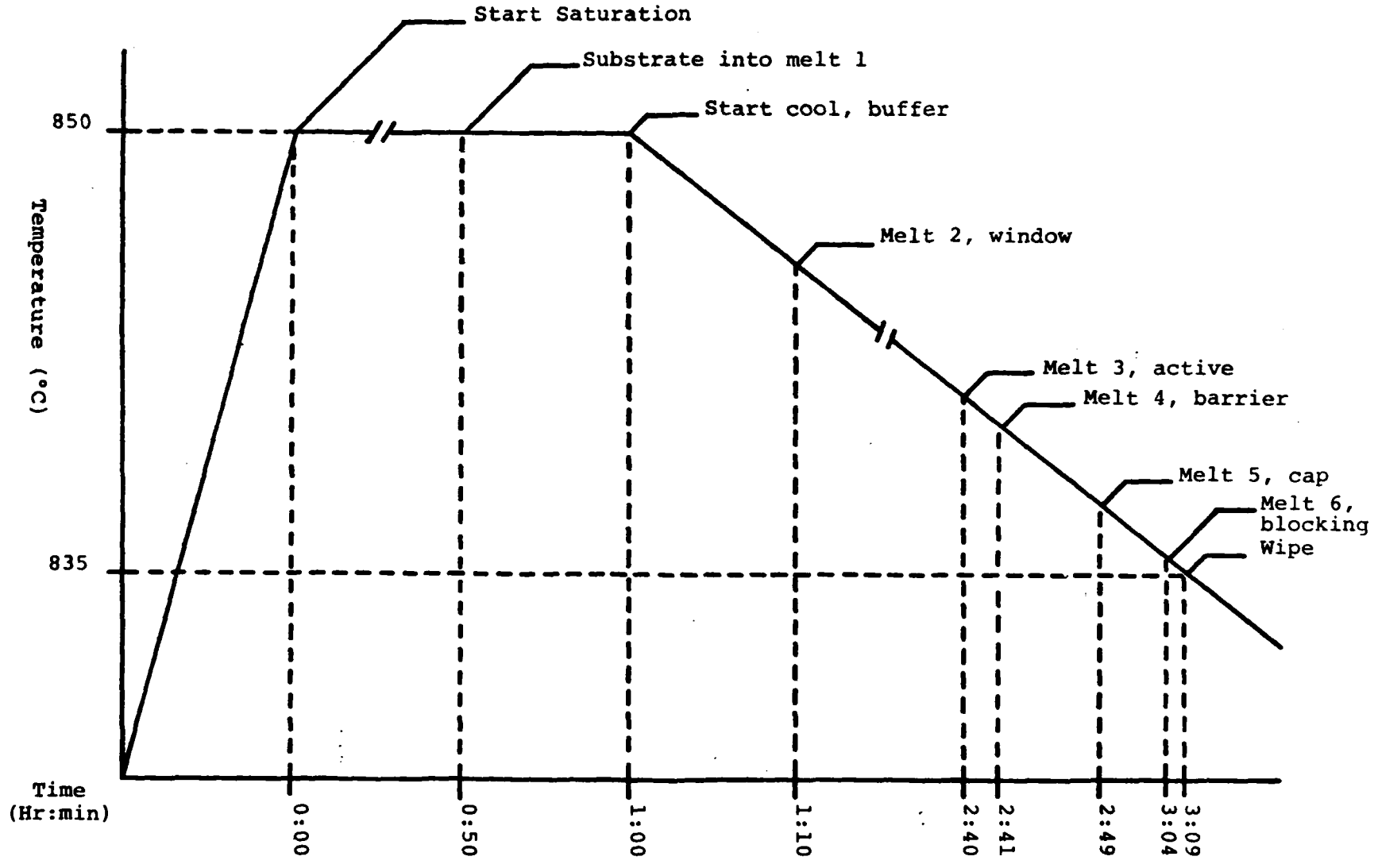
Melt Compositions for Double Heterojunction Epitaxial Synthesis of Etched Well Light Emitting Diodes.
(Weights in mg.)

Layer	*GaAs	Ga	Al	Te	Si	Ge
1	0.6K	5.0K	-	2.0	-	-
2	1.2K	10.0K	9.0	4.0	-	-
3	0.6K	5.0K	0.8	-	-	20
4	0.6K	5.0K	6.0	-	-	0.1K
5	0.6K	5.0K	1.2	-	-	0.5K
6	0.6K	5.0K	-	-	-	-

* Polycrystalline source wafers.

need for careful preweighing of GaAs for each melt. In addition, higher quality layers and increased run to run layer thickness reproduceability have been achieved with this technique. Once saturation has been achieved, epitaxial synthesis proceeds according to the time temperature program shown in Figure 7. Individual layers are epitaxially deposited by advancing the substrate through the consecutive growth bins for a precisely controlled time interval. Because growth rates for the various melts are well defined for a fixed starting temperature and cooling rate, layer thickness can be accurately and reproduceably controlled using this technique.

Figure 7. Temperature Program Used in the Liquid Phase Epitaxial Growth of Double Heterojunction LED Structures.



3.1.2 WAFER PROCESSING FOR ETCHED-WELL LIGHT EMITTING DIODE CHIP FABRICATION

In the chip fabrication process, the key to central alignment of the emitting spot on the p-side of the wafer to the etched well on the n-side of the wafer, is a hinged photomask shown in Figure 8. The index step assures repeat positioning and orientation. The mask can be flipped from one side to the other for paired exposure.

As described in the previous section, a GaAs substrate, shown in Figure 9, is processed in the epitaxial system to produce layers as shown in Figure 10. An 800 Å layer of Si_3N_4 is deposited on the blocking layer of the wafer by chemical vapor deposition using a mixture of SiH_4 and NH_3 which is thermally decomposed using N_2 as a carrier gas at 600°C. The SiH_4/NH_3 ratio of 1:5 results in a deposition rate of ∿ 40Å/Min. This step is shown in Figure 11. A photoresist layer is then applied to both sides of the wafer using a spin-on method of 4000 RPM for 40 seconds. This produces a resist film thickness of ∿ 5000 Å. The wafer is baked for 20 min at 100°C. Figure 12 shows the wafer with resist on both sides.

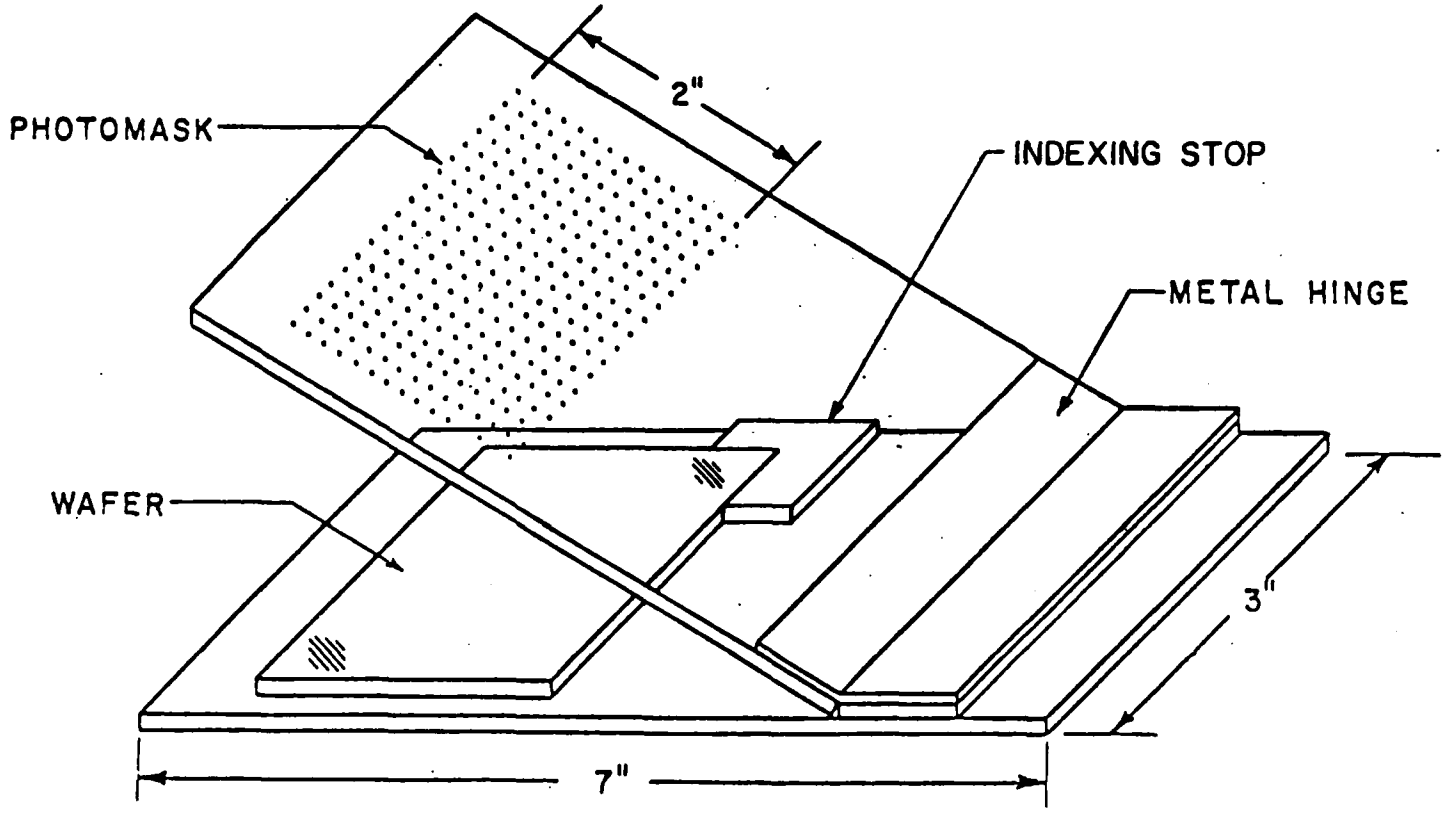
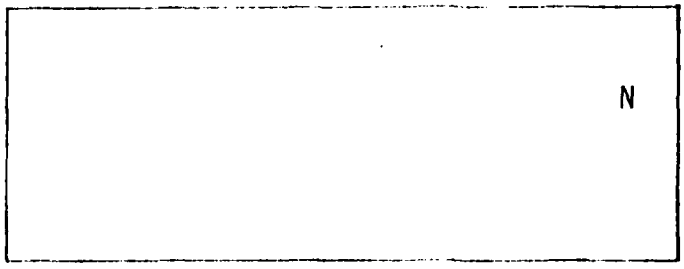
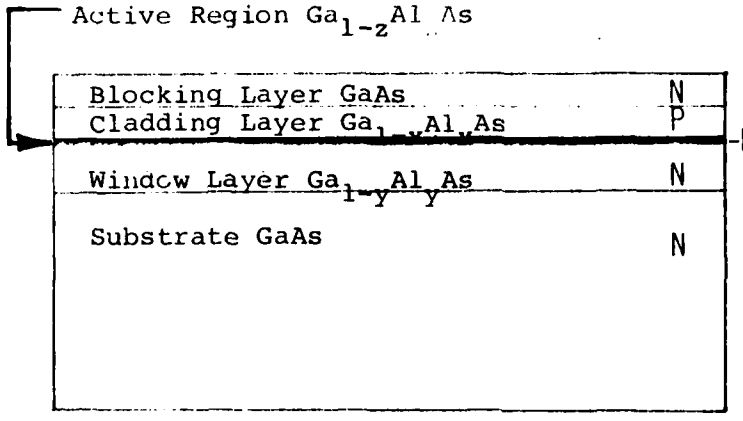


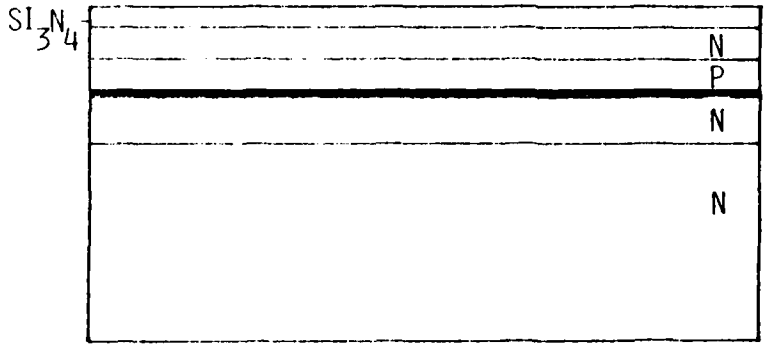
Figure 8 - Sketch of Hinged Photomask.



9. SUBSTRATE



10. L.E.D. STRUCTURE
LIQUID PHASE EPITAXY



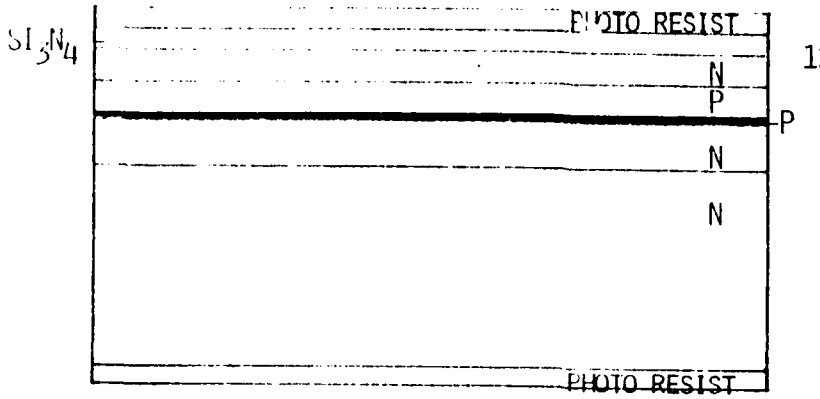
11. P-SIDE Si_3N_4 DEPOSITION

The wafer is placed in the hinged mask, aligning a cleaved edge to the index stop and mask frame. The wafer is placed in the mask p-side up, facing the 40 μm dot pattern. The n-side faces the 9 mil dot pattern. The mask is placed in a UV exposure system and exposed for 25 seconds each side. After development and annealing the wafer appears as in Figure 13.

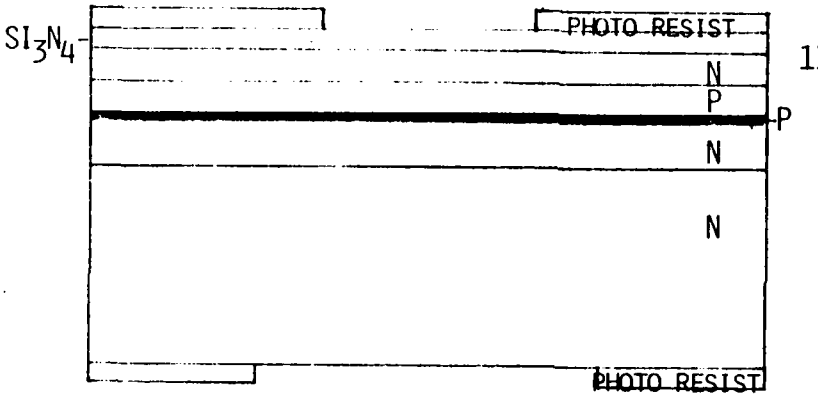
The masked wafer is etched on the n-side for 20 seconds using a 3:1:1 etch. H_2Po_3, H_2O_2, H_2O to yield a 9 mil dot pattern $\sim$ 2 μm in depth. During this step the p-side is protected by the Si_3N_4. The n-side etched wafer is shown in Figure 14.

The p-side of the wafer is plasma etched through the Si_3N_4 to produce a 40 μm dot pattern, as shown in Figure 15. In Figure 16 the photo-resist has been removed from both sides of the wafer. The Si_3N_4 film will allow for a selective Zn diffusion which will penetrate the 40 μm wells opened thru the Si_3N_4 mask.

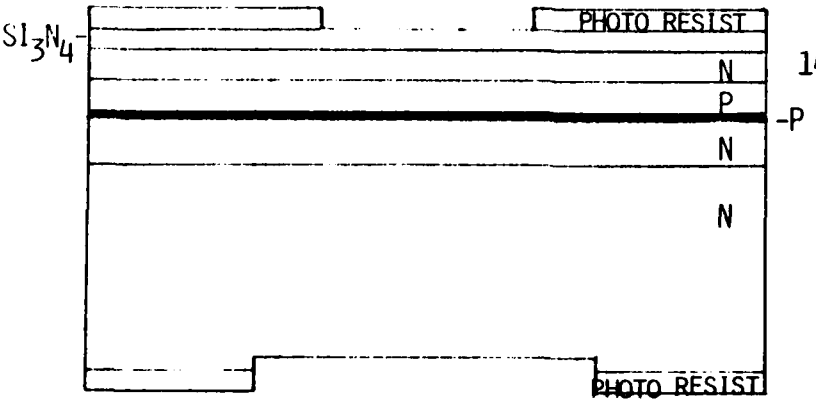
Figure 17 shows the wafer after zinc diffusion. Details of the diffusion furnace are shown in Figure 18. The figure illustrates the semi-sealed ampoule diffusion technique. The furnace is movable, and after the system has been purged and sealed, the furnace is rolled over



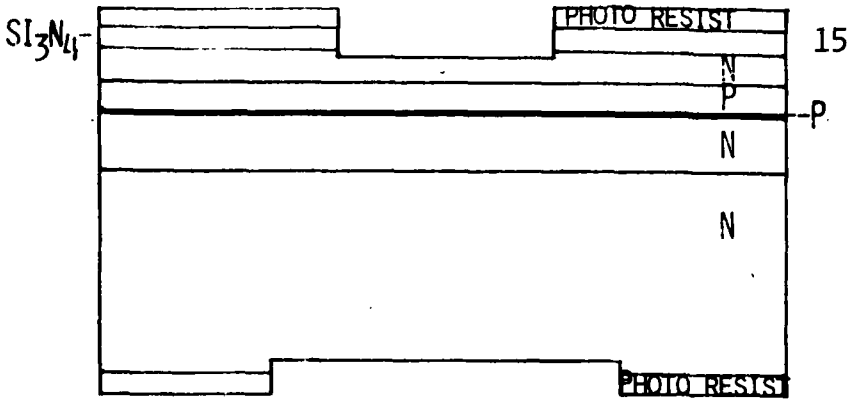
12. P-SIDE AND N-SIDE PHOTO RESIST



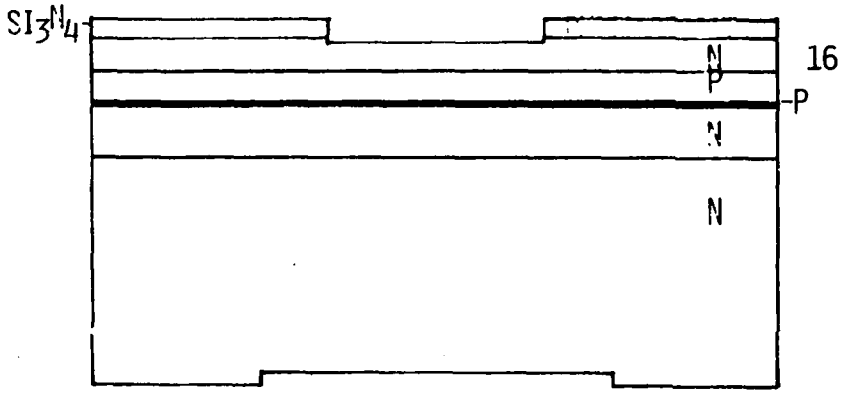
13. DOUBLE SIDED ALIGNMENT AND EXPOSURE, HINGED MASK



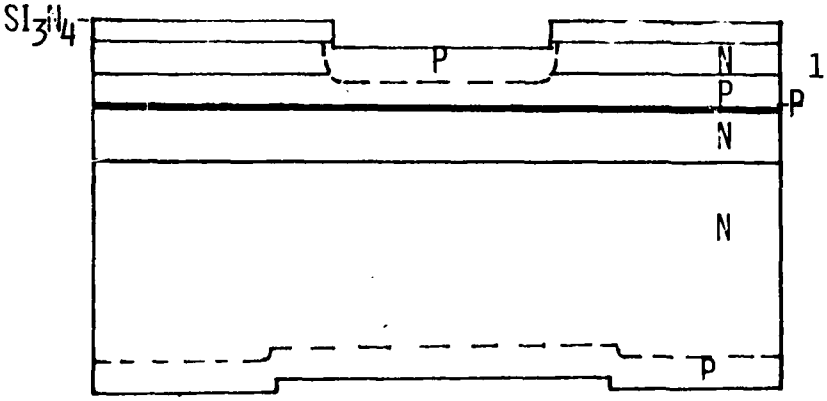
14. N-SIDE WELL DEFINITION ETCH



15. P-SIDE SI_3N_4 AND CLEAN-UP ETCH



16. PHOTO RESIST REMOVAL



17. SELECTIVE ZN DIFFUSION

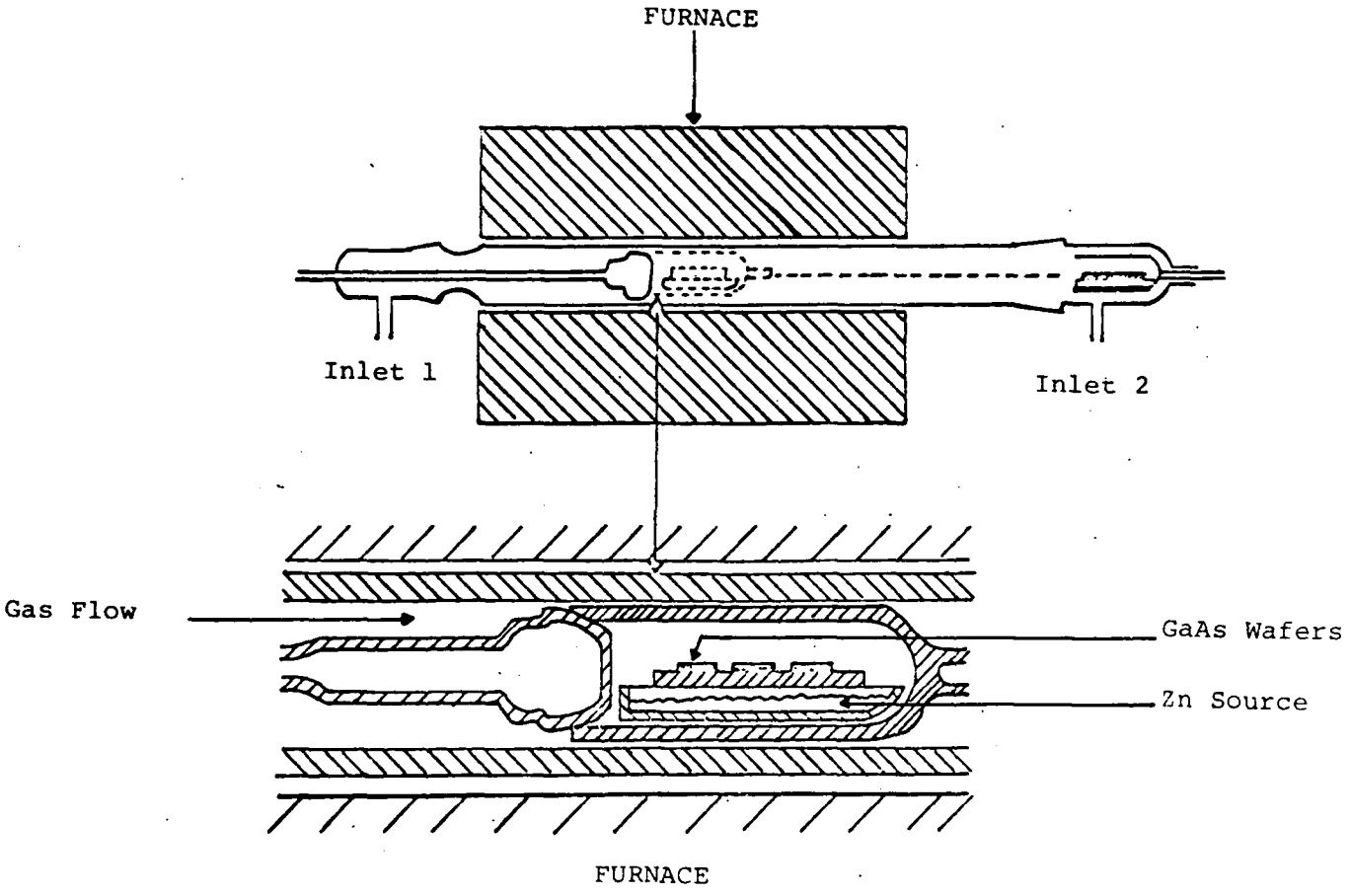


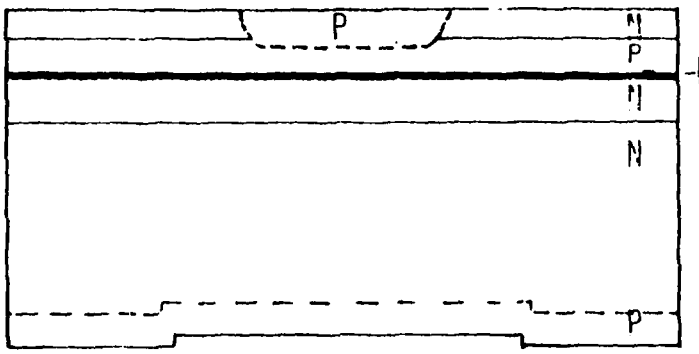
Figure 18 - Detail of Diffusion Furnace.

the ampoule area. At 700°C diffusion temperature, a 1 μm depth can be attained in about 30 minutes. Following the diffusion the Si_3N_4 mask is removed by plasma etching. The wafer at this point is shown in Figure 19. The p-side is then masked with wax so that the n-side diffused skin can be etched in 3:1:1. The etch follows the surface contour, thus retaining the 9 mil diameter dot pattern. This step is shown in Figure 20.

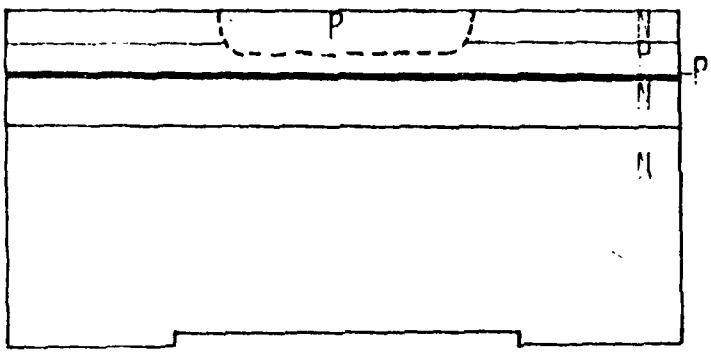
The next step in the process is metallization using standard vacuum technology. Ti(500Å), Pd(1000Å) and Au(1000Å) layers are deposited on the p-side of the wafer, while AuGe (1500Å) and Au(1000Å) layers are deposited on the n side, as shown in Figure 21.

Photo-resist is applied to the p-side metallization and processed to provide a 24 x 24 mil aperture on 26 mil centers allowing a 2 mil "street" in the X and Y direction for scribing. The n-side is wax masked, and in an Electro-plating bath, a half-mil thick gold pad is deposited in the 24 X 24 aperture. These steps are illustrated in Figures 22, 23 and 24.

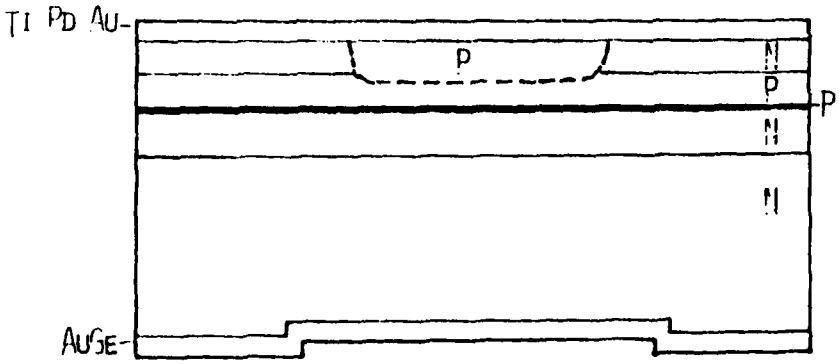
The wafer is further processed by applying photo-resist to the n-side in preparation for the n-side well etching, as shown in Figures 25 and 26. The re-alignment mask has been used to preserve the alignment



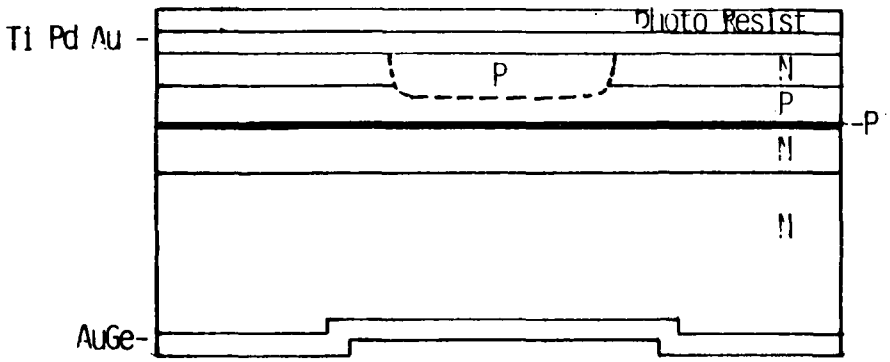
19. Si_3N_4 Removal



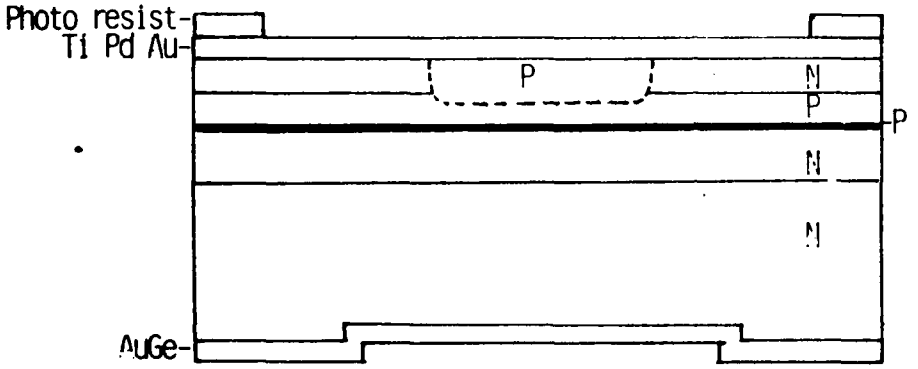
20. N-Side contour etch to remove diffused surface



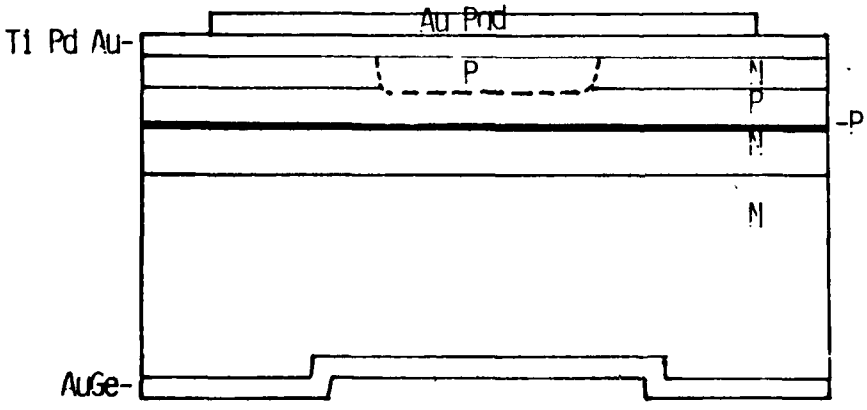
21. P and N-side metalization



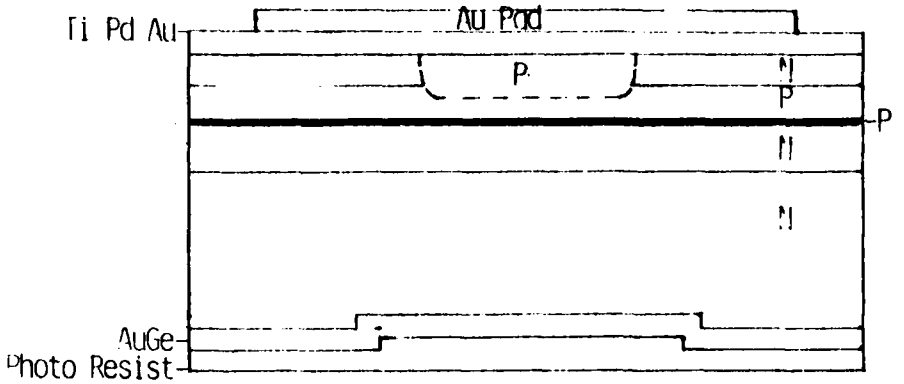
22. P-Side Photo Resist



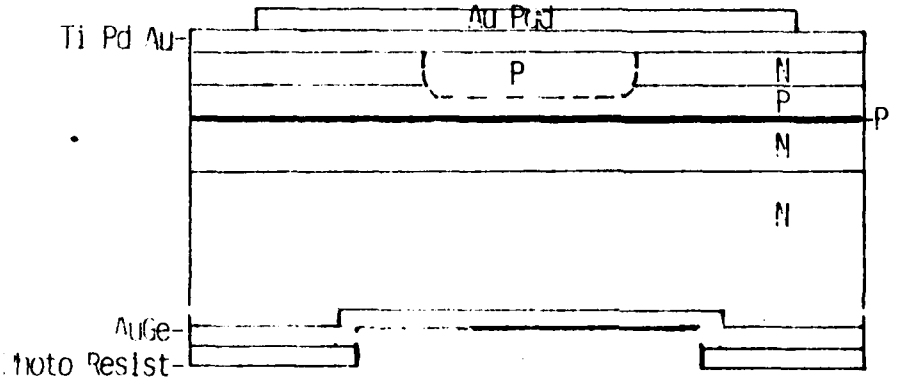
23. P-Side Alignment and Exposure



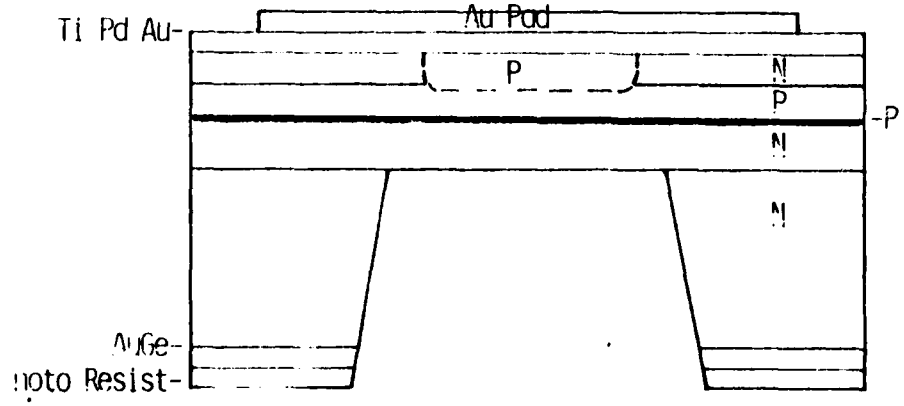
24. P-Side Electro-plated Au Bonding Pad



25. N-Side Photo Resist



26. N-Side Re-alignment and Exposure



27. N-Side Well Etching

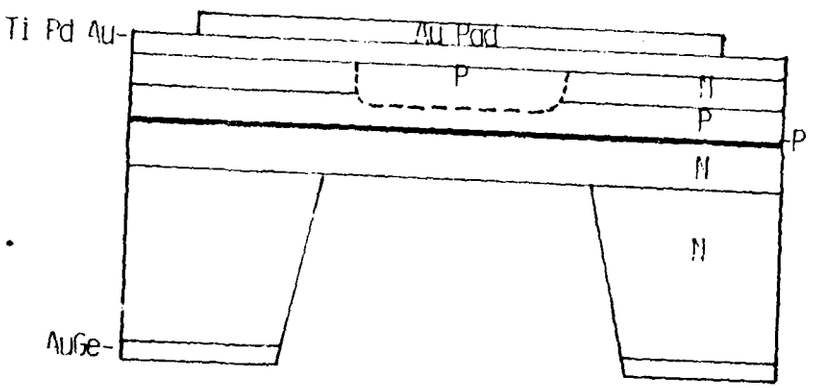
between the 9 mil dot on the n-side to the 40 μm dot on the p-side.

The AuGe metal is etched with a KI solution down to the GaAs substrate. A 30% H_2O_2 etch with the pH controlled to 8.5 using NH_4OH prevent oxidation and etch thru of the GaAlAs window layer. The etched well has dimensions of 10 mils in diameter and approximately 4.2 mils in depth. Figure 27 shows the wafer in the etch condition while Figure 28 shows the finished wafer form. Figure 29 shows the p and n-sides in views which depict the essential features more clearly. Figure 30 is a process flow sheet listing the process steps.

3.2 PACKAGE TECHNOLOGY

3.2.1 PACKAGE DESIGN

The basic package was designed around a high frequency transistor package which contained a mounting stud with low inductance "wings" brazed to a BeO insulating substrate. The coaxial design of the LED package using this approach is shown in Figure 31. The added components comprise a ferrule which serves to contain the fiber and a sleeve, which secures the ferrule to the header and maintains fiber alignment.



28. Photo Resist Removal and Finished Device

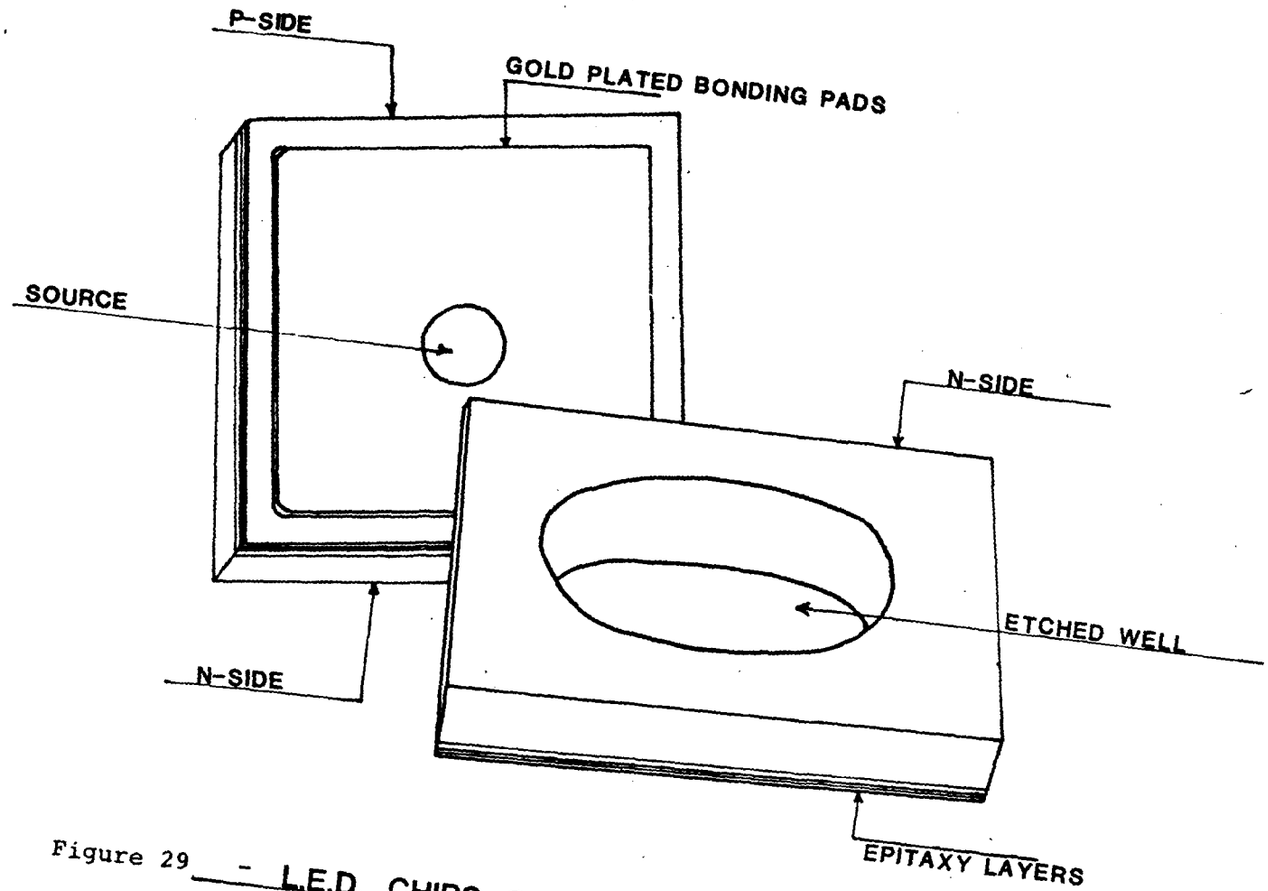


Figure 29 - L.E.D. CHIPS SHOWING P AND N-SIDES

Figure 30 - [illegible]

Run # _____ Date Received _____

Comments:

1. Si_3N_4 Deposition _____
2. Cleaning _____
3. Lapping to 4.5 mils _____
4. N-side Photo-resist _____
5. P-side Photo-resist _____
6. Pre-bake 20 min. _____
7. Alignment & exposure _____
8. Developing _____
9. Post bake 10 min. _____
10. N-side 2 μm etch _____
11. P-side plasma-etch _____
12. (Chemical) Resist removal _____
13. (Plasma) Resist removal _____
14. Selective Zn diffusion _____
15. Si_3N_4 Removal _____
16. N-side contour 2 μm etch _____
17. Metallization cleaning _____
18. P-metallization _____
19. N-metallization _____
20. N-side photo-resist _____
21. N-side realignment _____
22. Exposure & developing _____
23. N-side etching _____
24. P-side electroplated (Au) _____
25. Final clean-up _____
26. Saw mounting _____
27. Dicing 24 mil (centers) _____
28. Saw dismounting _____
29. Cleaning _____
30. Chip Q.C. _____
31. Probe test _____
32. Evaluation _____

COMMENT ON PROCESSING:

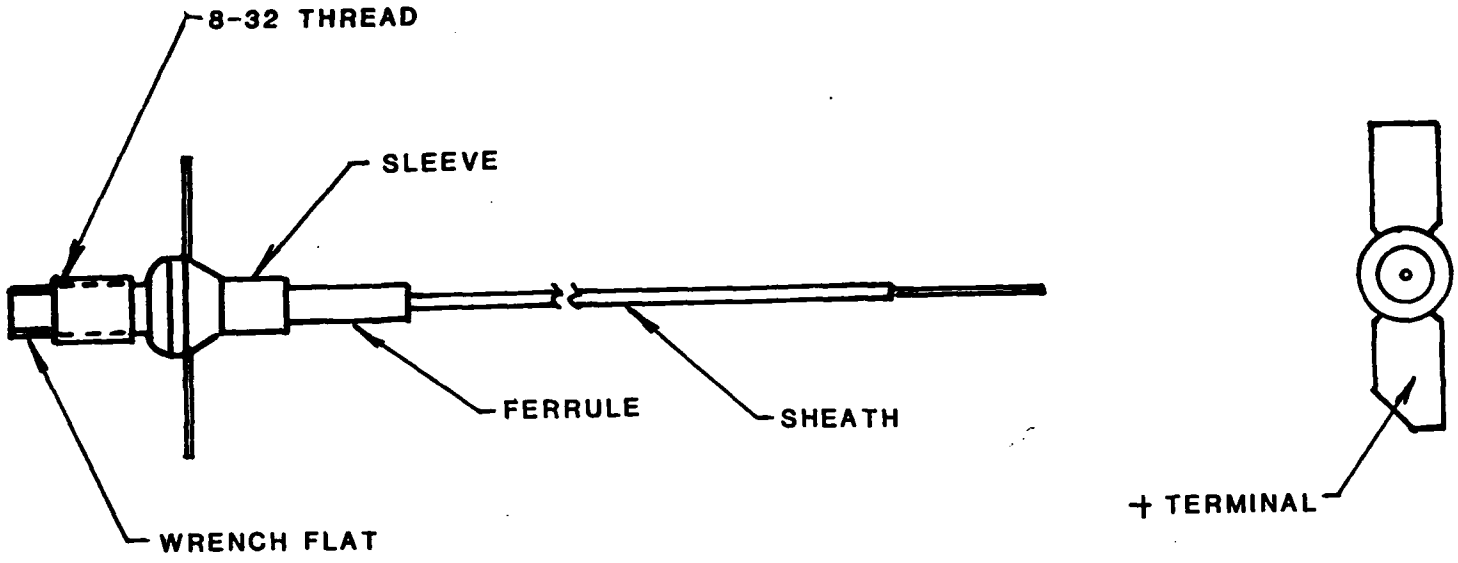
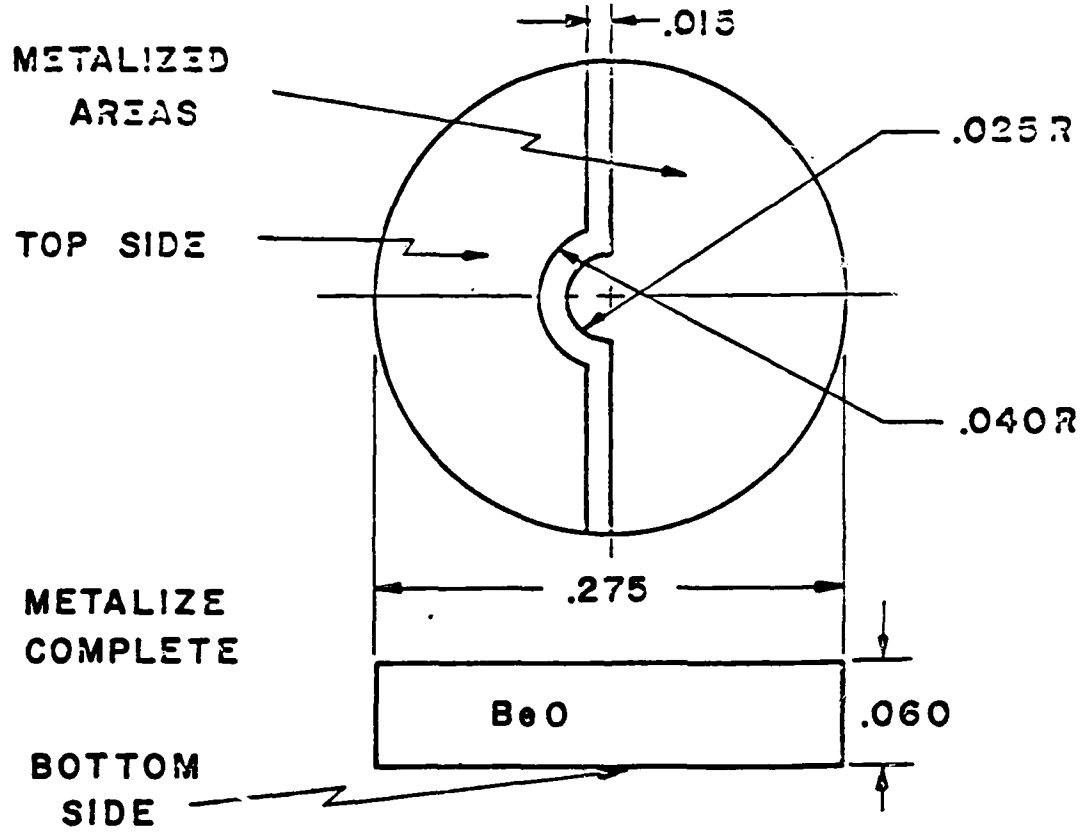


FIGURE 31 - FIBER COUPLED LED

Figure 32 shows details of the BeO substrate indicating the metallized area and central target area for mounting the LED chips. Figure 33 shows the BeO brazed to the copper screw stud and terminals brazed in place. Figures 34, 35 and 36 give details of the stud and terminals. Figure 37 shows the ferrule and sleeve assembly. The sleeve is free to slide along the ferrule and has a slot across the mounting face to enable the sleeve to straddle the terminals brazed to the BeO substrate. Figure 38 illustrates two methods by which the fiber is epoxied to the ferrule. The lower figure illustrates the fiber sheathing epoxied to the ferrule. The upper figure indicates the fiber directly epoxied to the ferrule. This second method provides mode stripping in the fiber cladding and serves to secure the fiber to the ferrule in such a manner as to inhibit fiber movement during the pull test performed on the finished device.

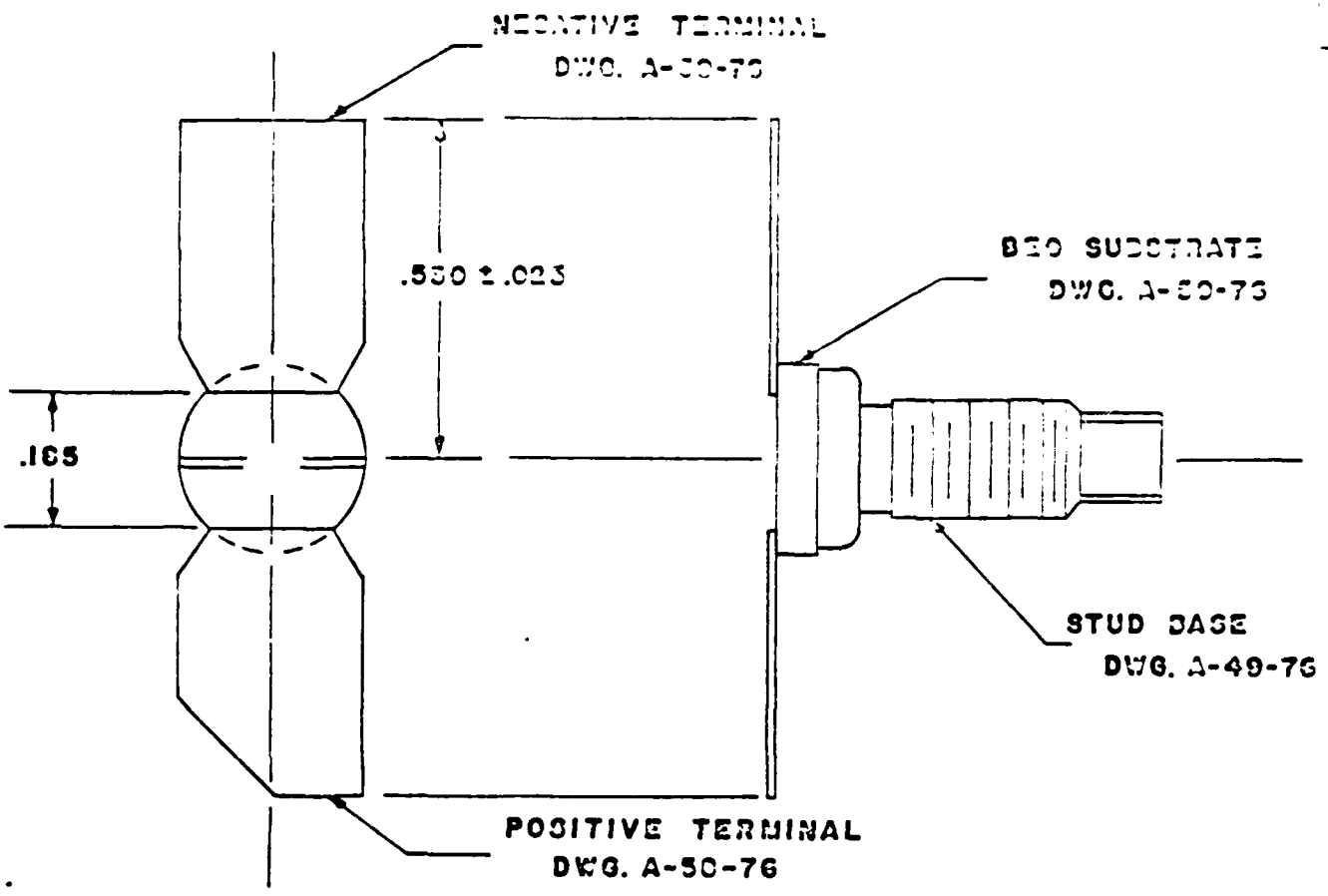
3.2.2 LIGHT EMITTING DIODE ASSEMBLY TECHNIQUE

The LED Assembly Flow Chart in Figure 39 indicates the sequential steps required to assemble the device. The first step in the process is the soldering of the



TOL. ± .002

LDT 177 BeO SUBSTRATE		
SCALE: 10X	APPROVED BY	DRAWN BY M.R.
DATE: 12-10-76		
Figure 32 - LED Chip Carrier (BeO Substrate).		
LASER DIODE LABS. INC.		DRAWING NUMBER

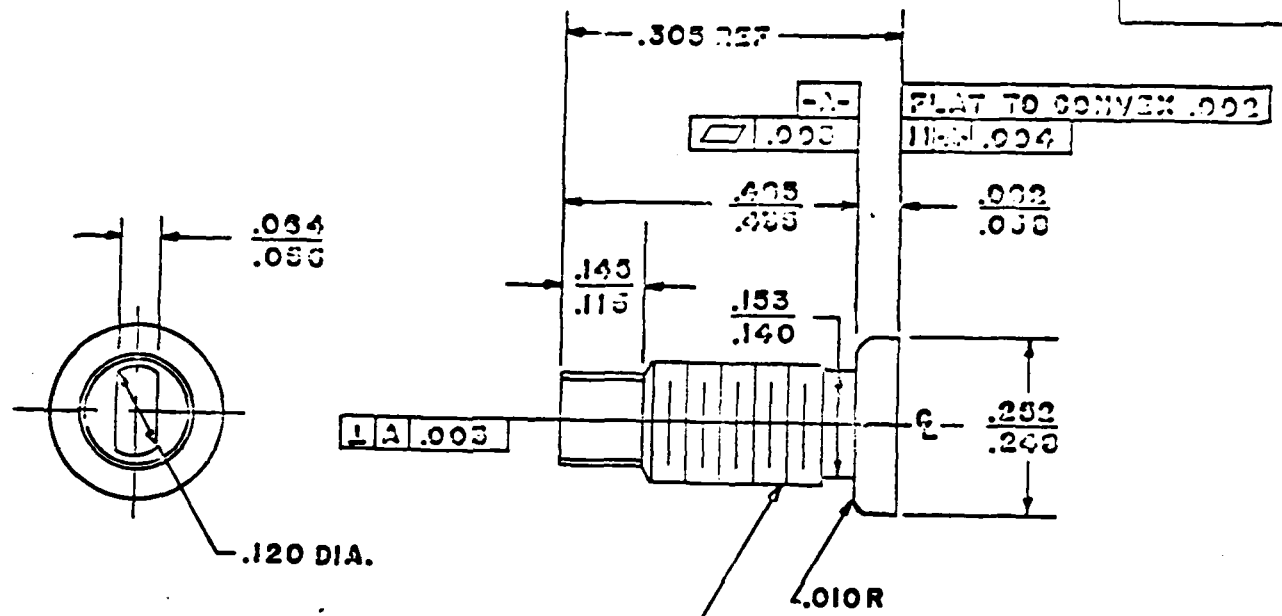


NOTES:

1) ASSEMBLE PARTS WITH BRAZE AT 600° C MIN.

2) FINISH –
DIE BOND AREA, 150μin. AU ONLY
STUD, 150μin. NI, IMMERSION AU
LEADS, 80μin. AU

LDT 177 STUD ASSEMBLY		
SCALE: 4X	APPROVED BY	DRAWN BY M.R.
DATE: 12-10-76		
Figure 33 - LED Stud Assembly.		
LASER DIODE LABS. INC.		DRAWING NUMBER



6-32 UNC-2A THREAD

PITCH DIA.

MAX. .1420 MIN. .1399

MAJOR DIA.

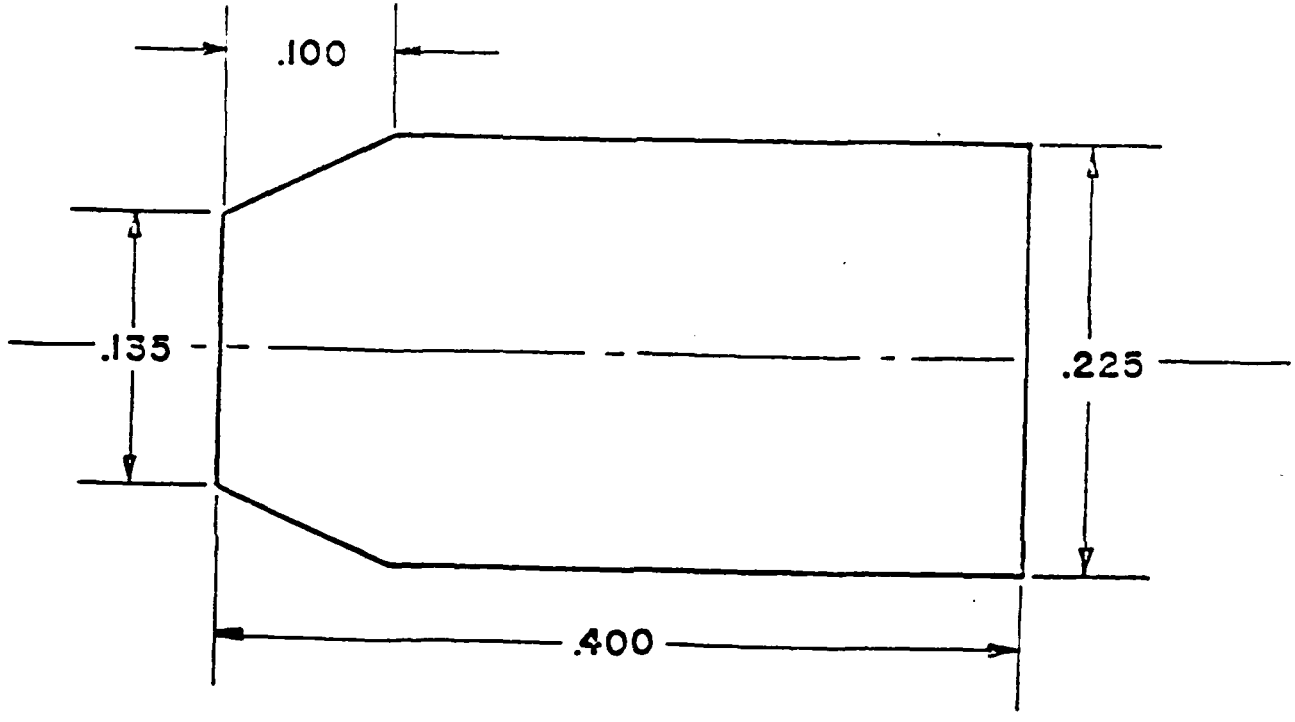
MAX. .1620 MIN. .1569

MATERIAL: OFHC OR Te-Cu

NOTES:

1) ALL DIA,S TO BE CONCENTRIC WITH ℄ WITHIN .005 T.I.R.
2) .002 MAX. BURR
3) COMPLETE THREADS TO WITHIN .040 OF HEAD

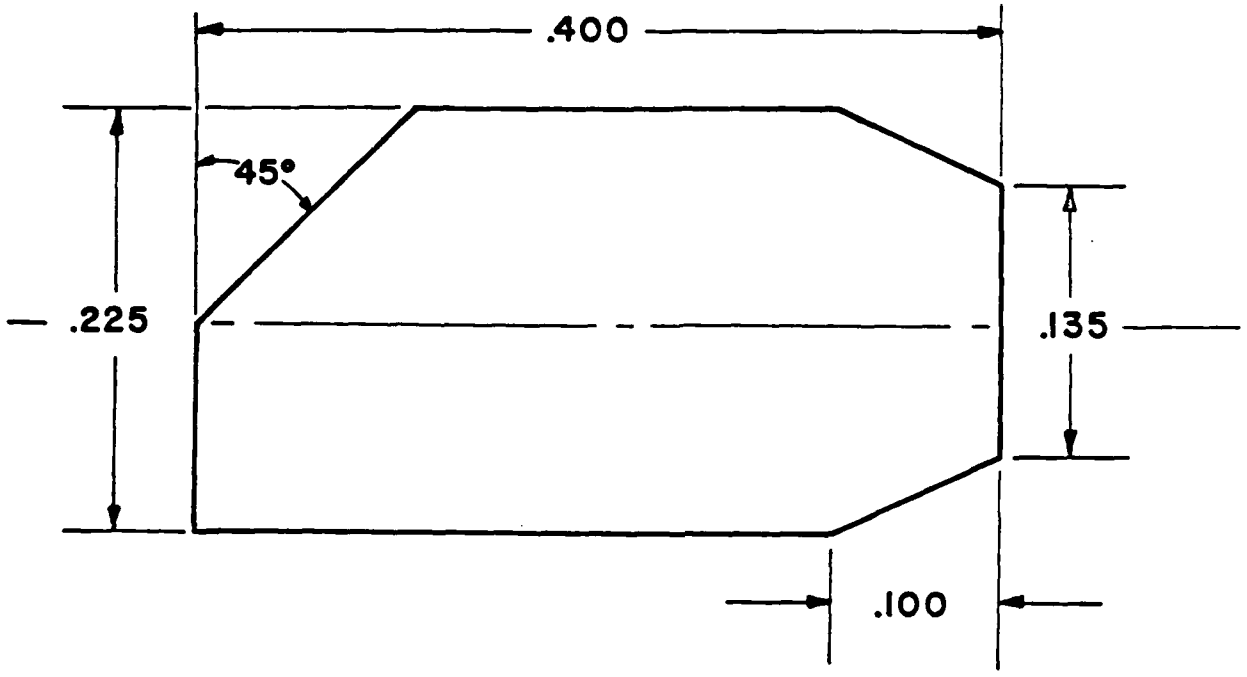
LDT 177 STUD BASE		
SCALE: 4X DATE: 12-10-70	APPROVED BY	DRAWN BY M.R.
Figure 34 - LED Stud Base.		
LASER DIODE LABS. INC.		DRAWING NUMBER



MATERIAL - KOVAR

TOL.± .002

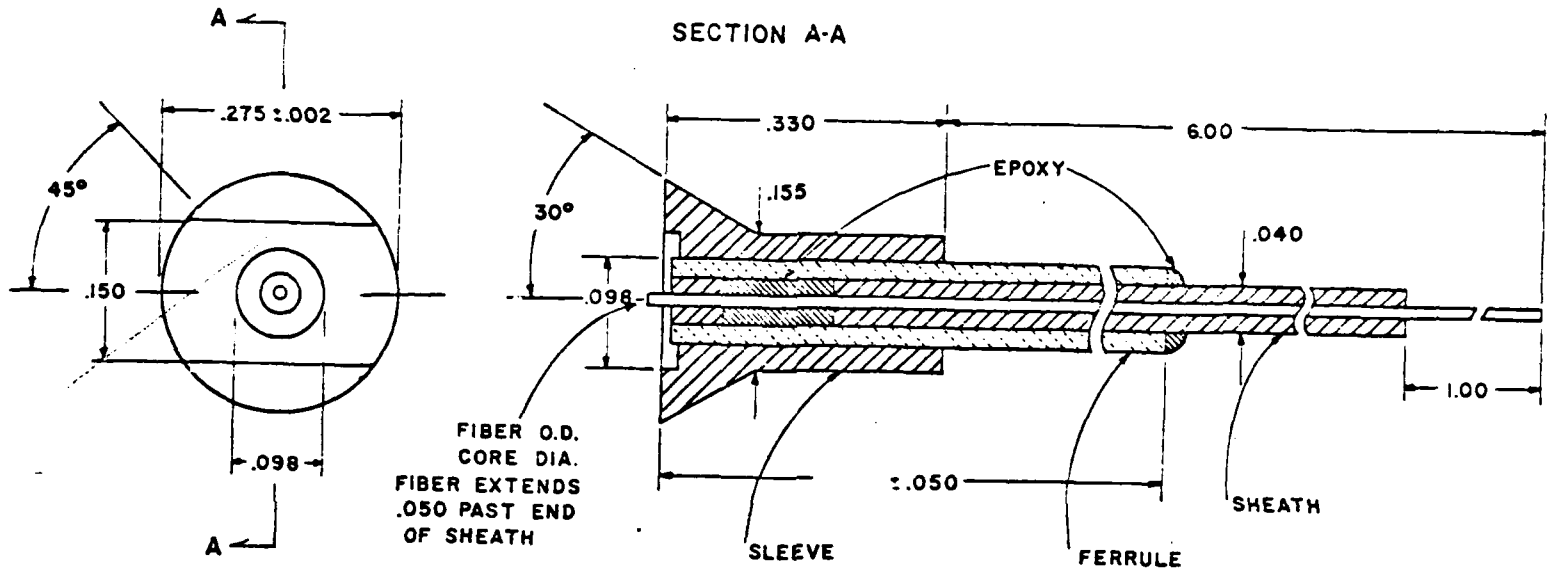
LDT 177 NEGATIVE TERMINAL		
SCALE:	APPROVED BY	DRAWN BY M.R.
DATE: 12-10-76		
Figure 35 - LED Electrode (NEG.).		
LASER DIODE LABS. INC.		DRAWING NUMBER



MATERIAL - KOVAR

TOL. ± .002

LDT 177 POSITIVE TERMINAL		
SCALE:	APPROVED BY	DRAWN BY M.R.
DATE: 12-10-76		
Figure 36 - LED Electrode (POS.).		
LASER DIODE LABS. INC.		DRAWING NUMBER



FIBER CHARACTERISTICS

CHARACTERISTICS	MIN.	MAX.	UNIT
ATTENUATION (AT λP) (8200Å)			
CORE DIAMETER			
CLADDING DIAMETER			
PROTECTIVE JACKET DIAMETER			
NUMERICAL APERTURE (N.A.)			
TENSILE STRENGTH			
BENDING RADIUS			

LDT 177 FIBER ASSEMBLY

SCALE: 10X | APPROVED BY | DRAWN BY

DATE: 11-23-76 | M.R.

Figure 37 - LED Fiber-Ferrule Assembly with Support Sleeve.

LASER DIODE LABS. INC. | DRAWING NUMBER

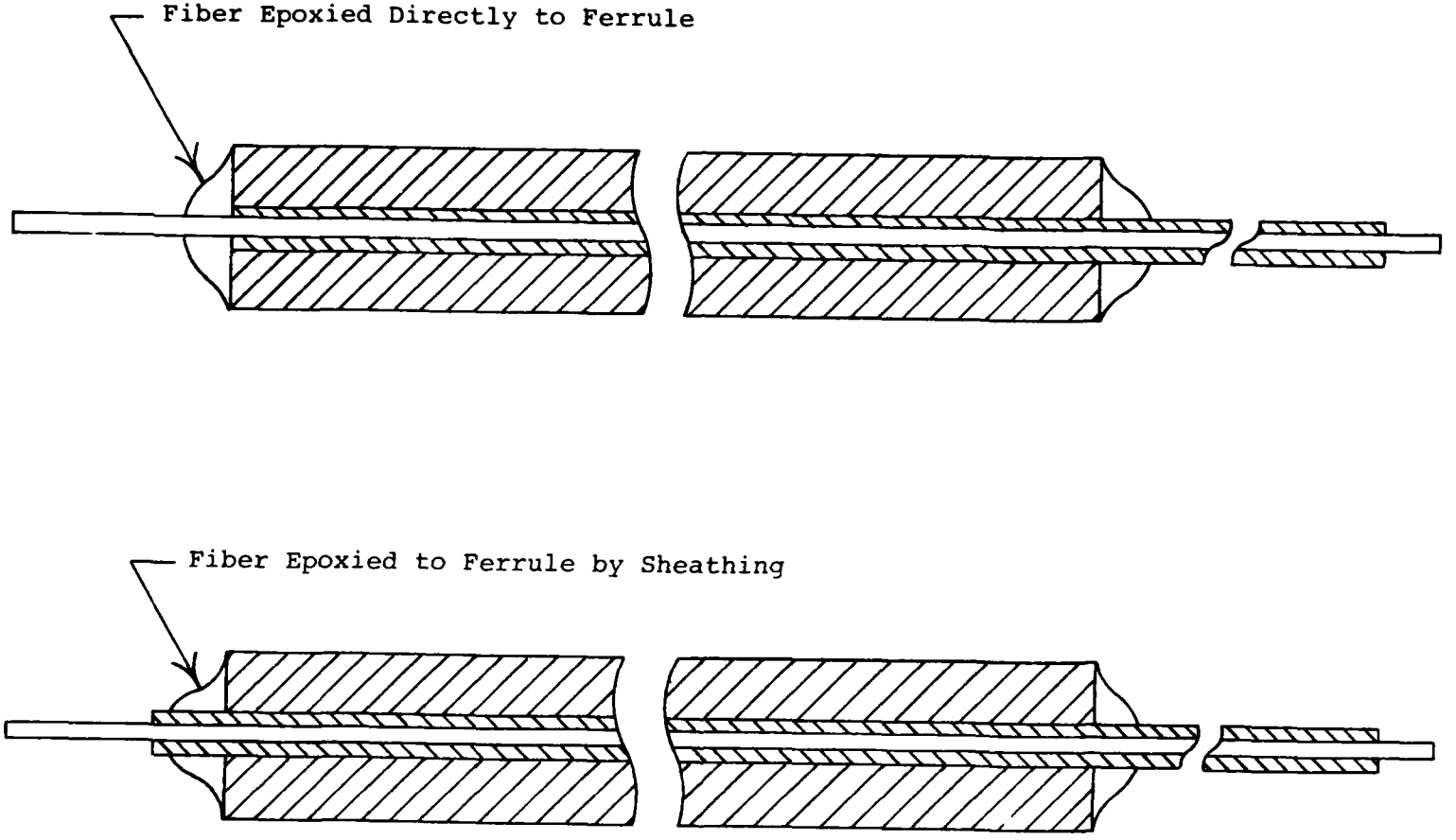


Figure 38 -Fiber Epoxied to Ferrule.

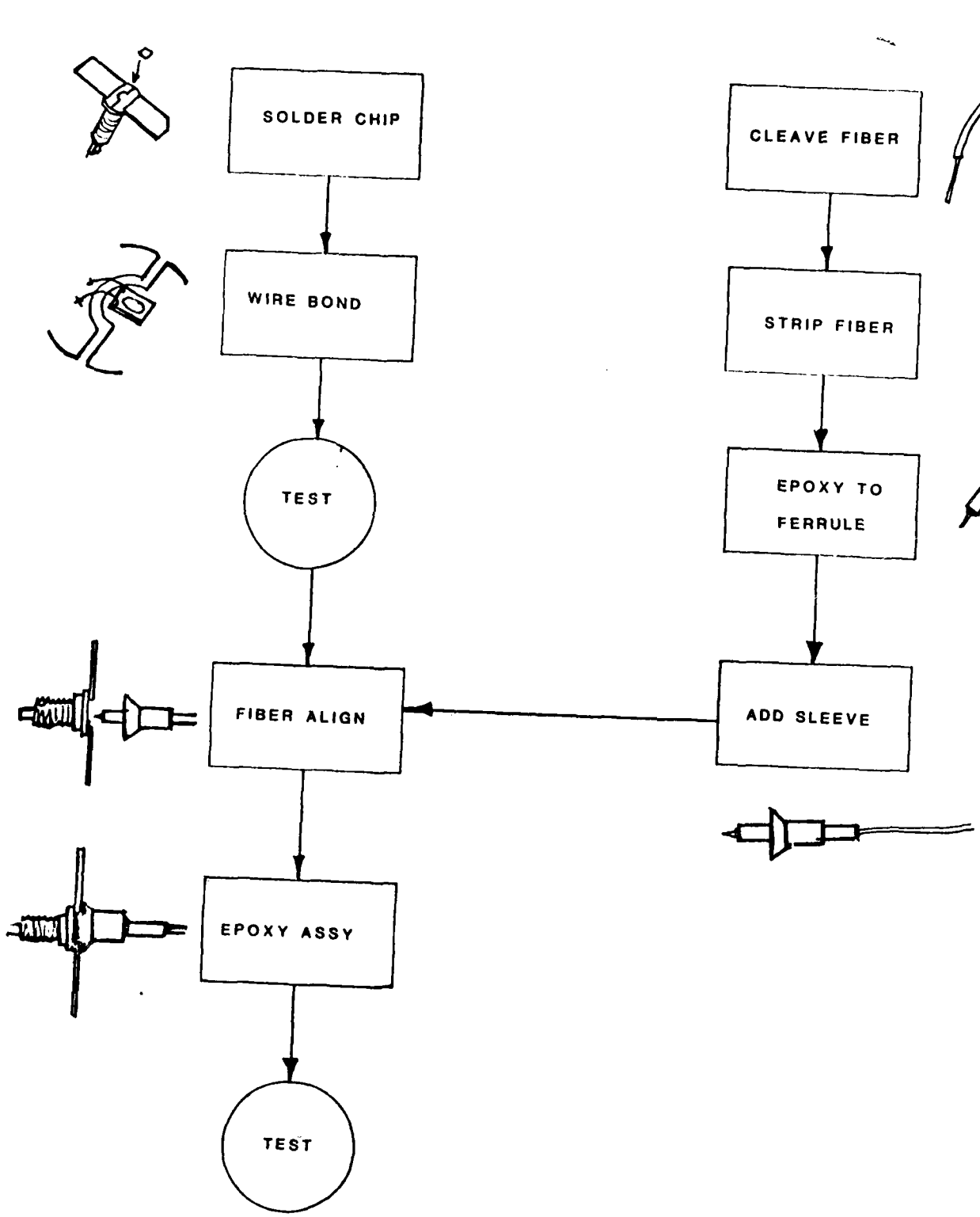


Figure 39 - LED ASSEMBLY FLOW CHART

of the LED chip to the header assembly using the graphite chip soldering fixture shown in Figure 40. Figure 41 shows details of the fixture, namely the fixture body, locating ring, weight, pellet and header. The body and locating ring are machined so that the parts are concentric and provide a central locating hole with respect to the metallized pattern on the BeO substrate. Solder cream, 60/40, Sn/Pb is used as the soldering medium. The boat is passed thru an Infra-Red belt furnace to affect the soldering. After a flux cleaning operation and visual inspection for proper solder flow, the devices are ready for wire bonding. Standard ultra-sonic wire bonding techniques are used to bond 2 mil gold wires from n-side of the chip to the metallized area on the BeO substrate. This double bonding is illustrated in the photo of Figure 42. At this point the device can be tested for essential characteristics and burned-in to assure stability.

Figure 43 is a sketch of the alignment fixture used to align a fiber with the LED chip. A quick insertion socket with finger contacts secures the header assembly in place, while the ferrule clamp, attached to a 3 axis

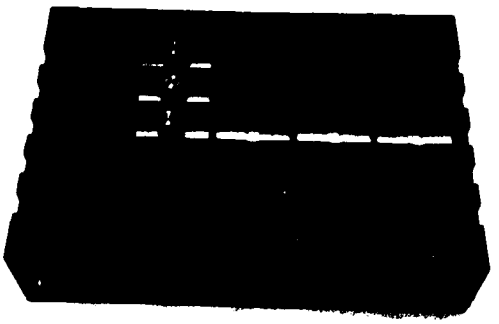


Figure 40 - Chip Soldering Fixture

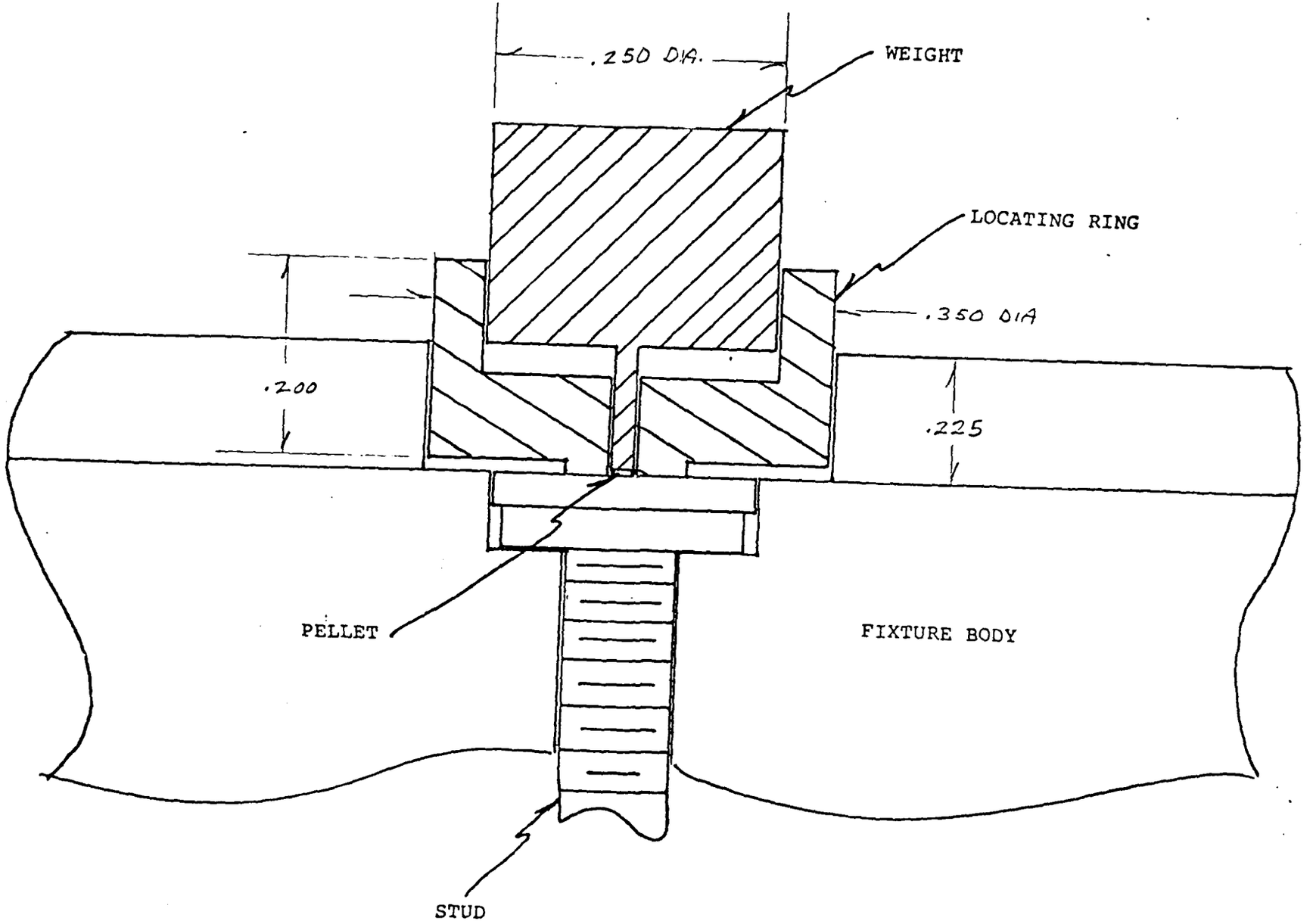


Figure 41 - Detail Chip Soldering Fixture.

FIG. 42 - **DOUBLE BONDED CHIP**

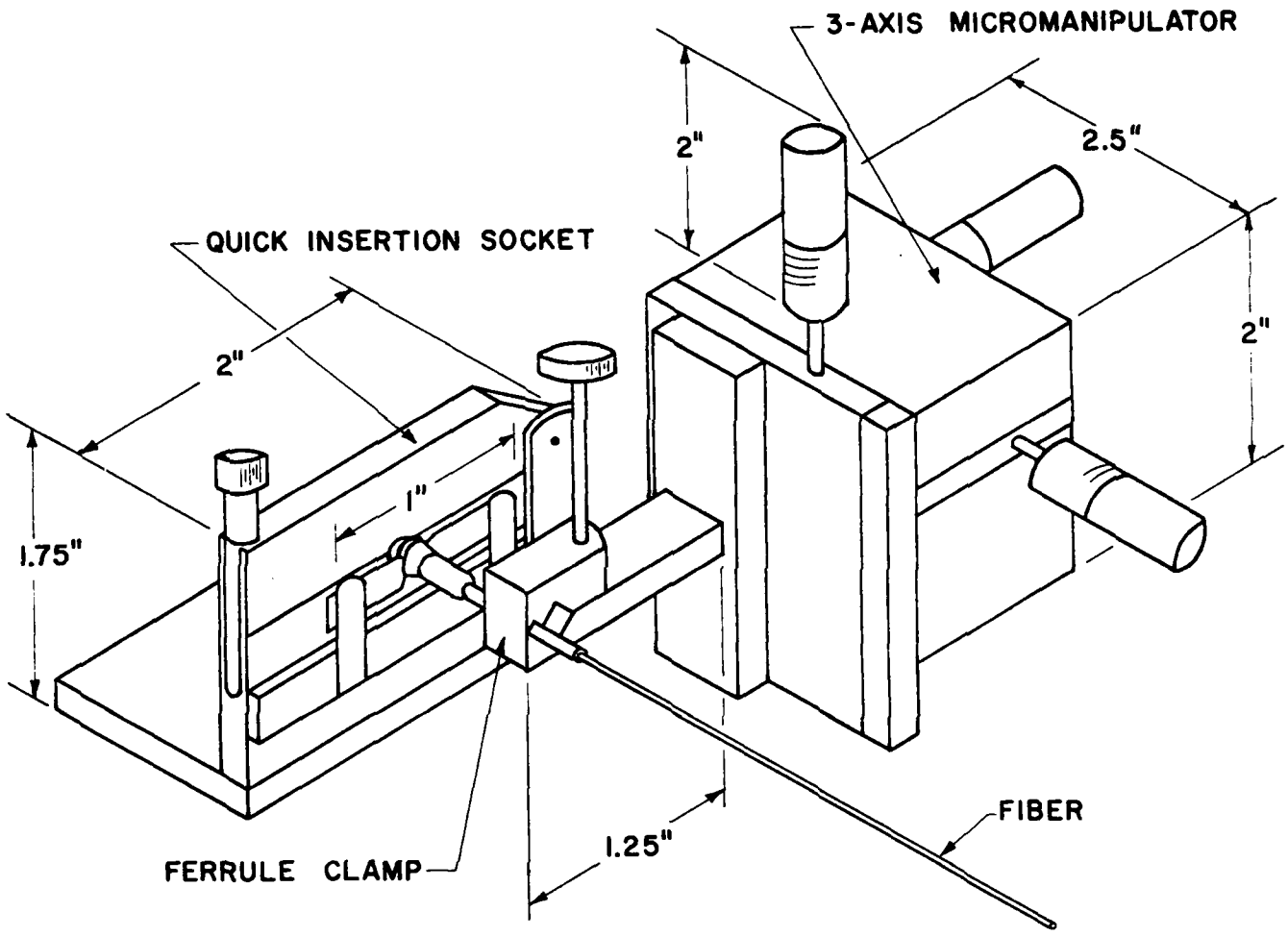


Figure 43 - Sketch of Alignment Fixture.

micromanipulator, holds the fiber ferrule assembly. In practice, the ferrule is placed in the micromanipulator clamp in such a manner that the sleeve may be slid back to expose the fiber protruding from the front of the ferrule. The fiber pigtail is positioned in front of the detector. Under microscopic examination, the fiber is maneuvered in the diode well, while observing the LED power meter for maximum reading with the diode forward biased. By rotating the sleeve on the ferrule, epoxy can be applied to the supporting faces of the sleeve. The sleeve can now be slid forward and placed in contact with the BeO mounting surface. The joint between the sleeve and ferrule is epoxied. The alignment and epoxying steps are illustrated in the photos of Figures 44, 45, 46 and 47. The alignment fixture is shown in the photos of Figures 48 and 49. The completed LED assembly is shown in Figure 50. The key to successful assembly of the fiber, ferrule and sleeve to the header, that is, one which will pass shock, vibration, thermal shock, pull test and moisture resistance, is the proper choice of the epoxy. In particular, moisture resistance is a critical test for epoxies as the original strength of epoxies will generally be degraded by the test.

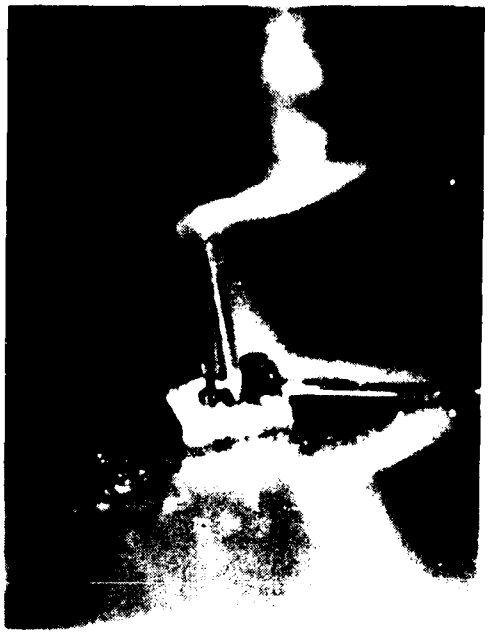


Figure 44 - Fiber Protruding from Ferrule, Positioned in Well.

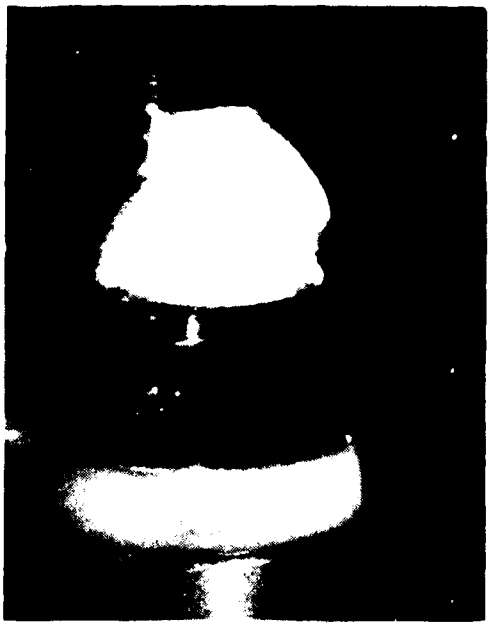


Figure 45 - Epoxy Applied to Sleeve.

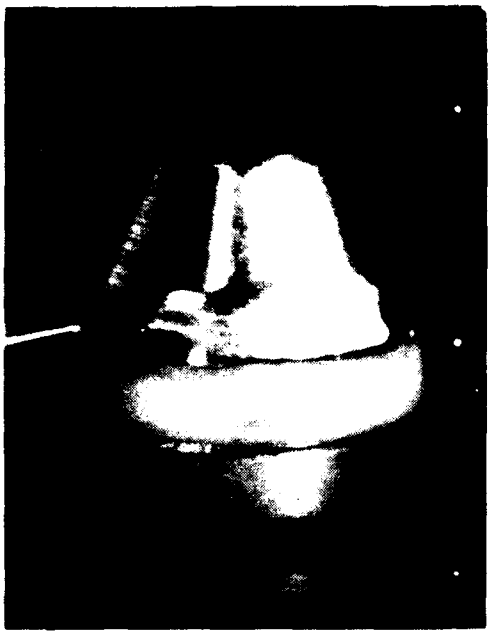


Figure 46 - Sleeve Epoxied to Header.

Figure 47 - Sleeve Epoxied to Ferrule.

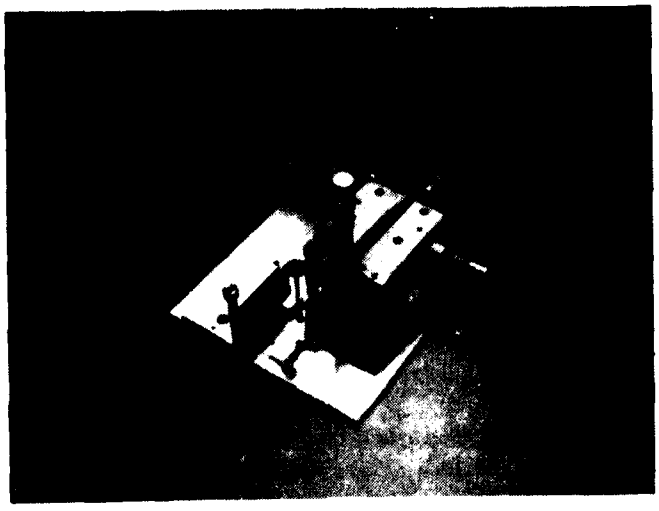


Figure 48 - Alignment Fixture.

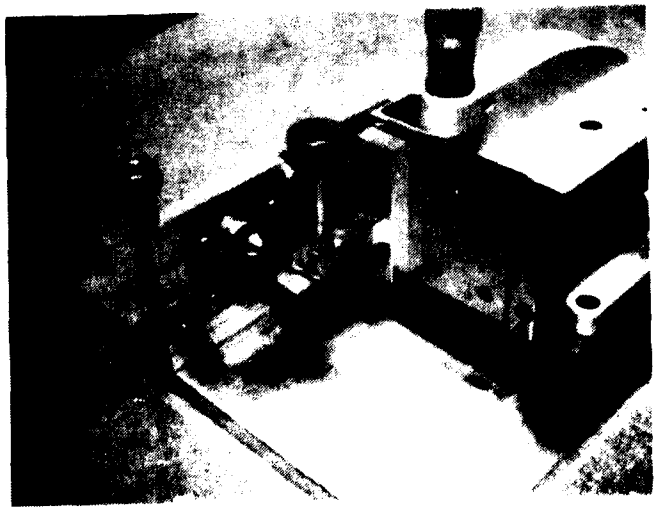


Figure 49 - Alignment Fixture (Close-Up).

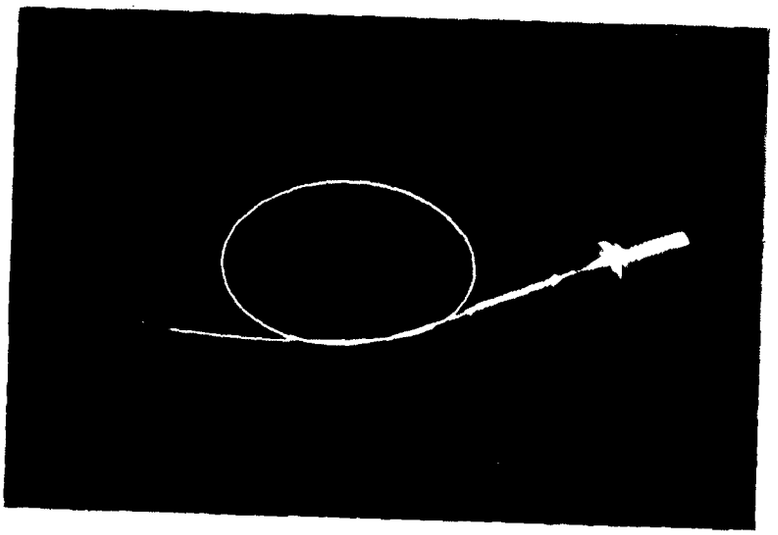


Figure 50 - LED With ITT Fiber.

A formulation by Epoxy Technology, designated X304, fulfilled all the specification requirements resulting in no failures for the environmental tests performed on the devices.

3.3 DEVICE EVALUATION AND TESTING

3.3.1 TEST EQUIPMENT

Fundamental to the testing of the LED devices is the test socket shown in Figures 51 and 52 in a generalized form. The socket allows quick insertion while maintaining rigidity in the closed position.

The equipment shown in Figure 53 is the basis for the peak optical power measurement. The test socket and EG&G detector head are mounted on an optical rail, the digital power readout indicator is to the right, a constant current power supply, with transient suppression of *LDL design, is to the left in the photograph.* By adjusting the spacing between the test socket and the detector head, unfibered devices can be measured into a particular NA. With an appropriate support for the fiber pigtail in front of the detector, completed devices can be measured. To the rear of the equipment in a mini-mono-chrometer used to spot check peak wavelength. Actual wavelength measurements are made on a 3/4 meter SPEX monochrometer capable of 1 Å resolution.

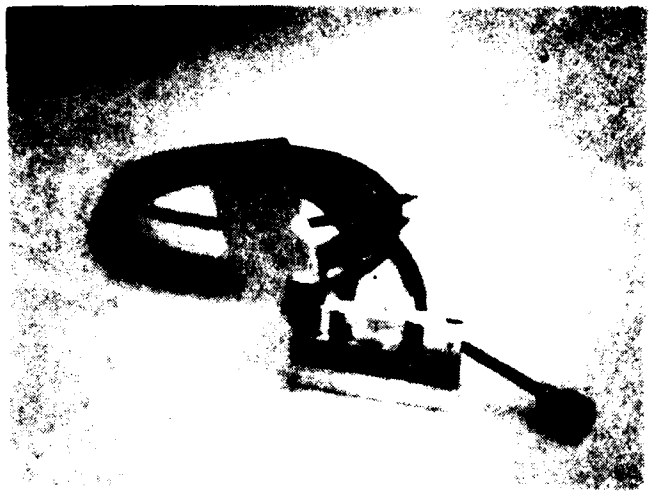


Figure 51 - Test Socket in Open Position.

Figure 52 - Test Socket in Closed and Clamped Position.

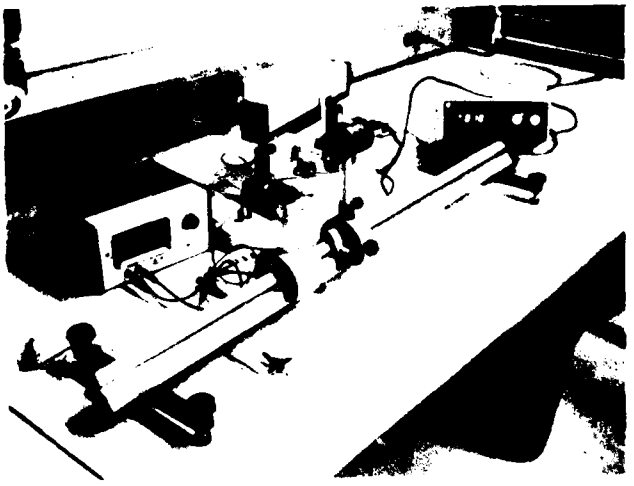


FIGURE 53 - PEAK OPTICAL POWER MEASUREMENT EQUIPMENT.

The rise and fall time test utilizes the equipment shown in Figure 54 which consists of a clock and power supply box for the driver and LED, the LED driver, the Avalanche Photo Detector and supply and a TEK 465 scope. Also visible in the figure is an optical rail and fixturing for alignment of the LED and detector. Figures 55 and 56 show two views of the driver chassis while Figure 57 is a schematic of the driver circuit. The DC supply contains a 10 MHZ crystal controlled oscillator divided down to 100 KHZ, controls for pulse amplitude and a dual one-shot for applying the trigger and pulse signals. The rise time of the pulse out of the driver is on the order of 3-4 ns at 100 KHZ with a 50% duty cycle. Figure 58 is a block diagram of the equipment connections. In Figure 59, the LED driver is used in a low duty cycle made to measure wavelength shift as a function of temperature in connection with a heated socket fixture. Figure 60 is a chart recorder plot of the output scan of the Spex 3/4 meter monochrometer indicating peak wavelength and 3 db spectral width.

Figures 61 and 62 show the physical set-up of the Linearity test equipment. The test fixture and APD detector are mounted on an optical rail for easy optical alignment.

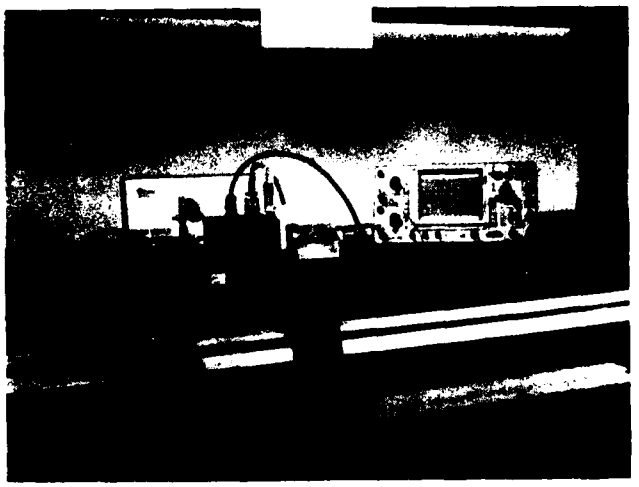


FIGURE 54 - RISE AND FALL TIME TEST SET.

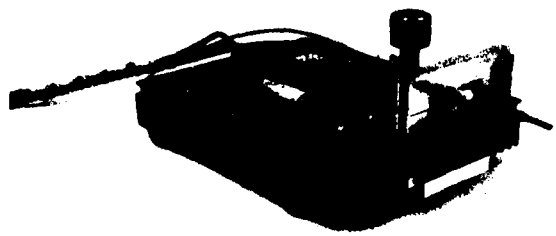


FIGURE 55, DRIVER FRONT VIEW

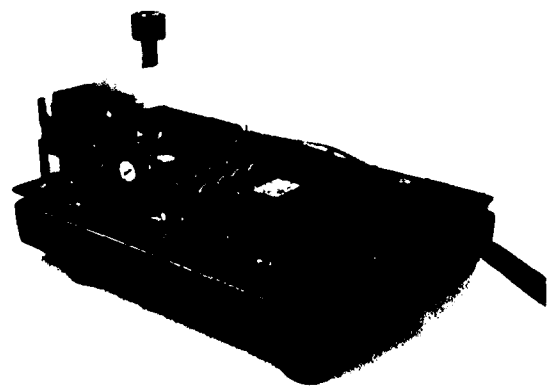


FIGURE 56 - DRIVER REAR VIEW

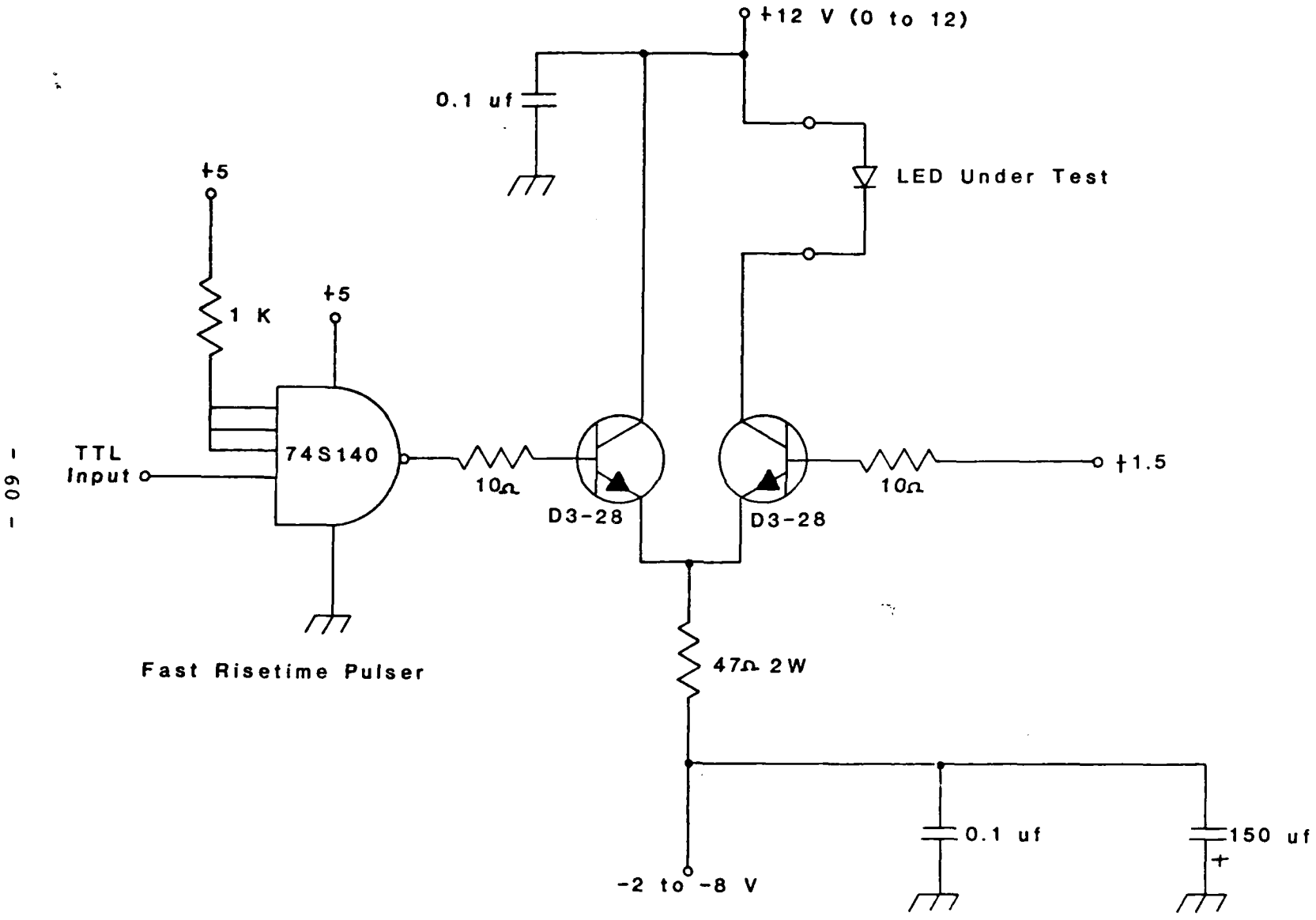


FIGURE 57 -FAST RISETIME HIGH PRECISION LED DRIVER

RISETIME & FALLTIME

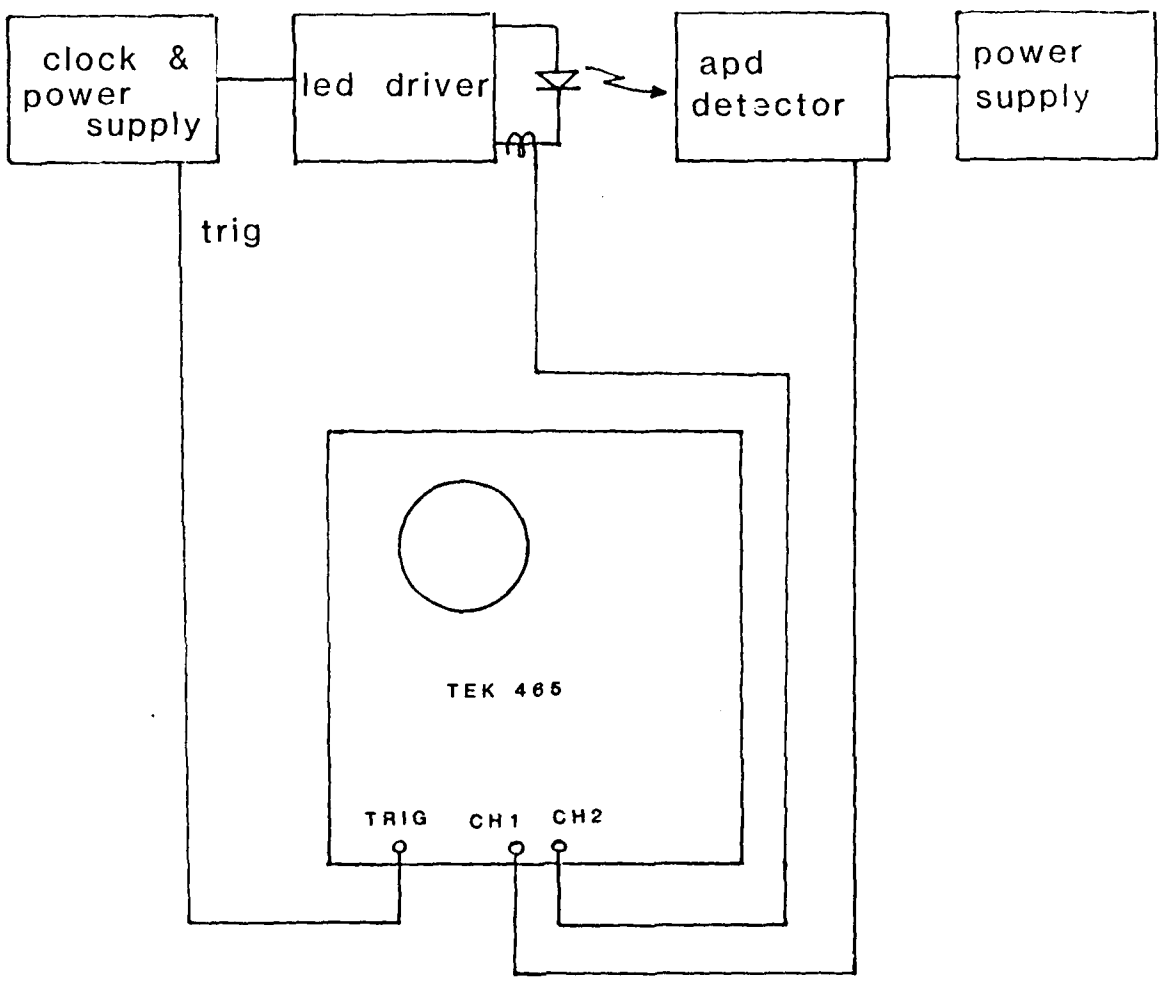


FIGURE 58 - BLOCK DIAGRAM RISE AND FALL TIME TEST

SCALE	APPROVED BY	DRAWN BY
DATE		

DRAWING NUMBER

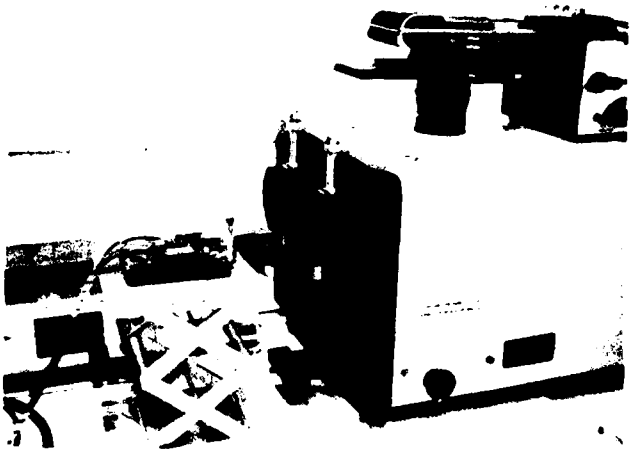


FIGURE 59 - LED DRIVER WAVELENGTH MEASUREMENT

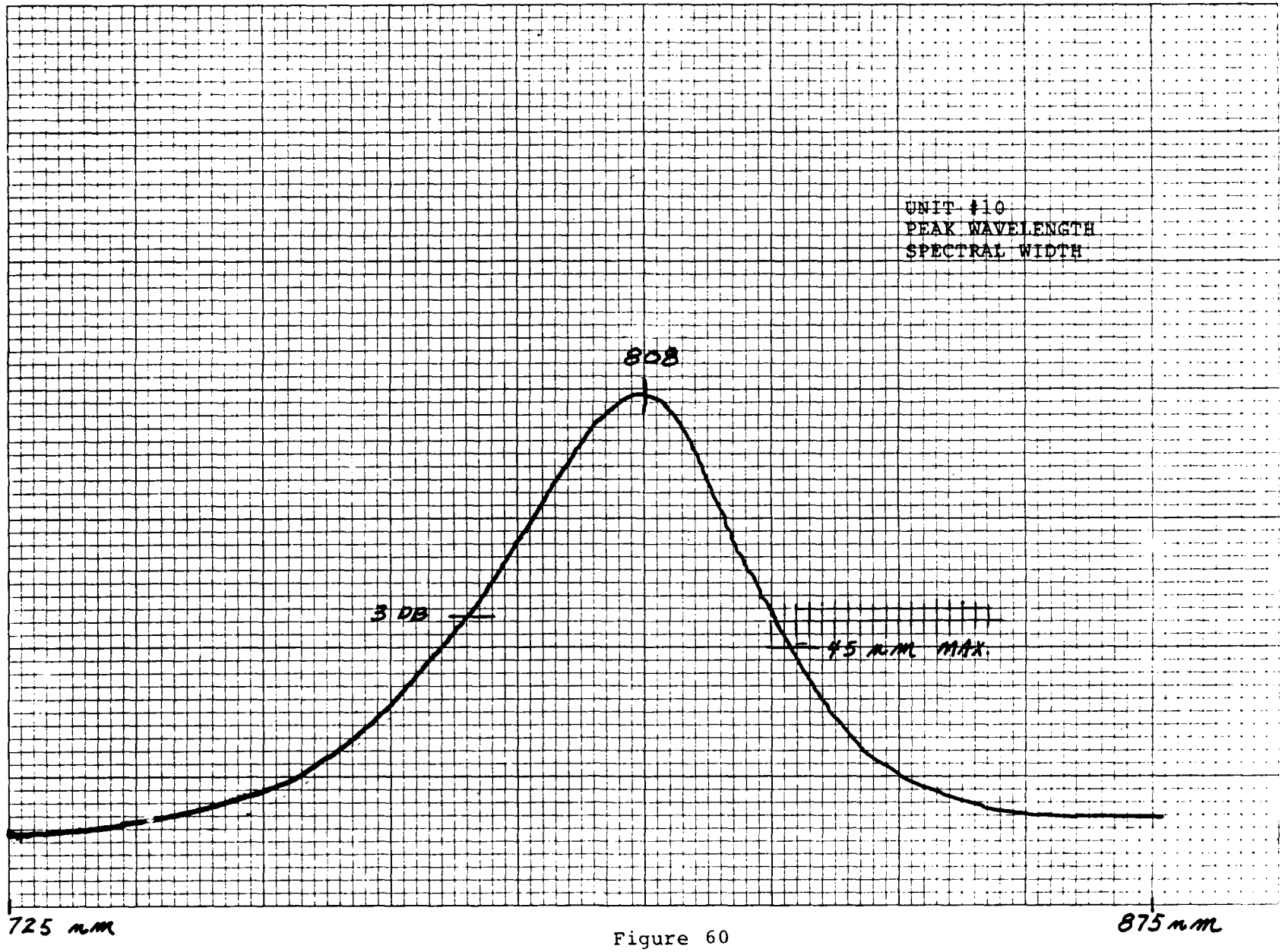

UNIT #10
PEAK WAVELENGTH
SPECTRAL WIDTH
808
3 DB
45 nM MAX.
725 nm
875 nm

Figure 60

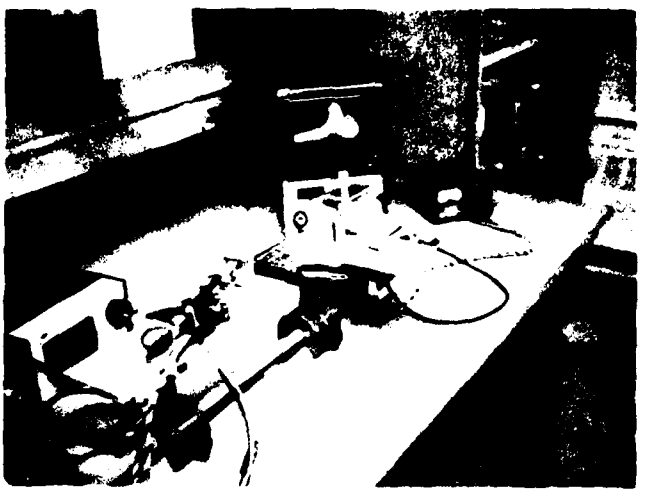


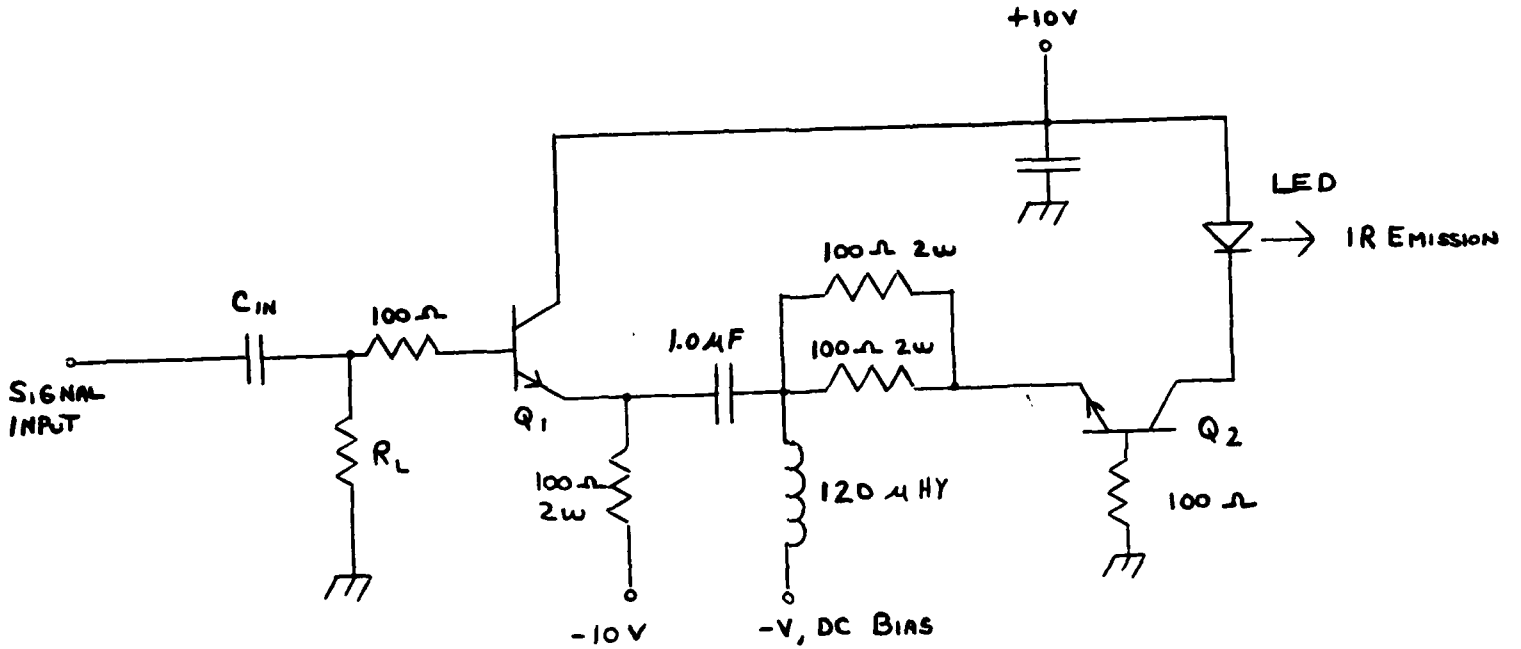
FIG 61-VIEW OF ANALYSER AND DETECTOR

FIG 62 -VIEW OF TEST JIG, SCOPE, GENERATOR

LED PS AND DETECTOR

The TEK 453 scope is used to monitor the applied 1 MHZ sine wave and set the signal to the proper level. The text fixture contains the impedance matching circuitry, shown in Figure 63, and the socket to hold the device. Figure 64 shows a typical spectrum analyser trace indicating second harmonic distortion of -35 db. A block diagram of the equipment connections is shown in Figure 65.

The fiber numerical aperture is measured using the Gonimeter shown in Figures 66 and 67. The LED is mounted on the rotatable head with the fiber fixed in place. The measurement is determined by setting the Goniometer to 0° then rotating to either side until 90° of the peak reading is attained. The two angles are averaged and the sine of the angle calculated to give the NA of the fiber. Figure 68 shows schematically the test set-up.



Q_1 AND Q_2 D3-28 CTC MICROWAVE TRANSISTOR

Figure 63 -Linearity Test Circuit.

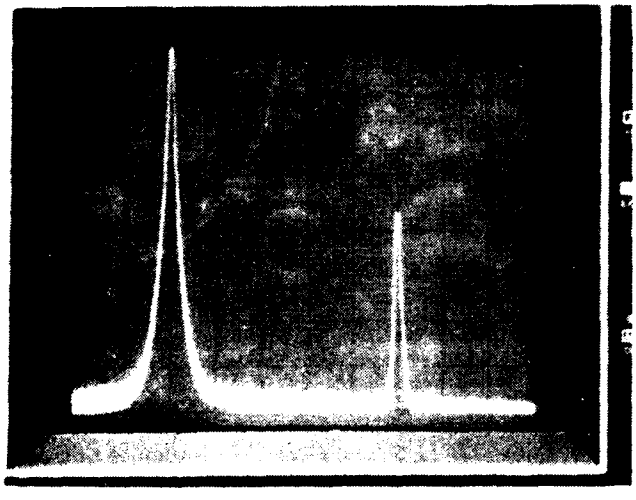
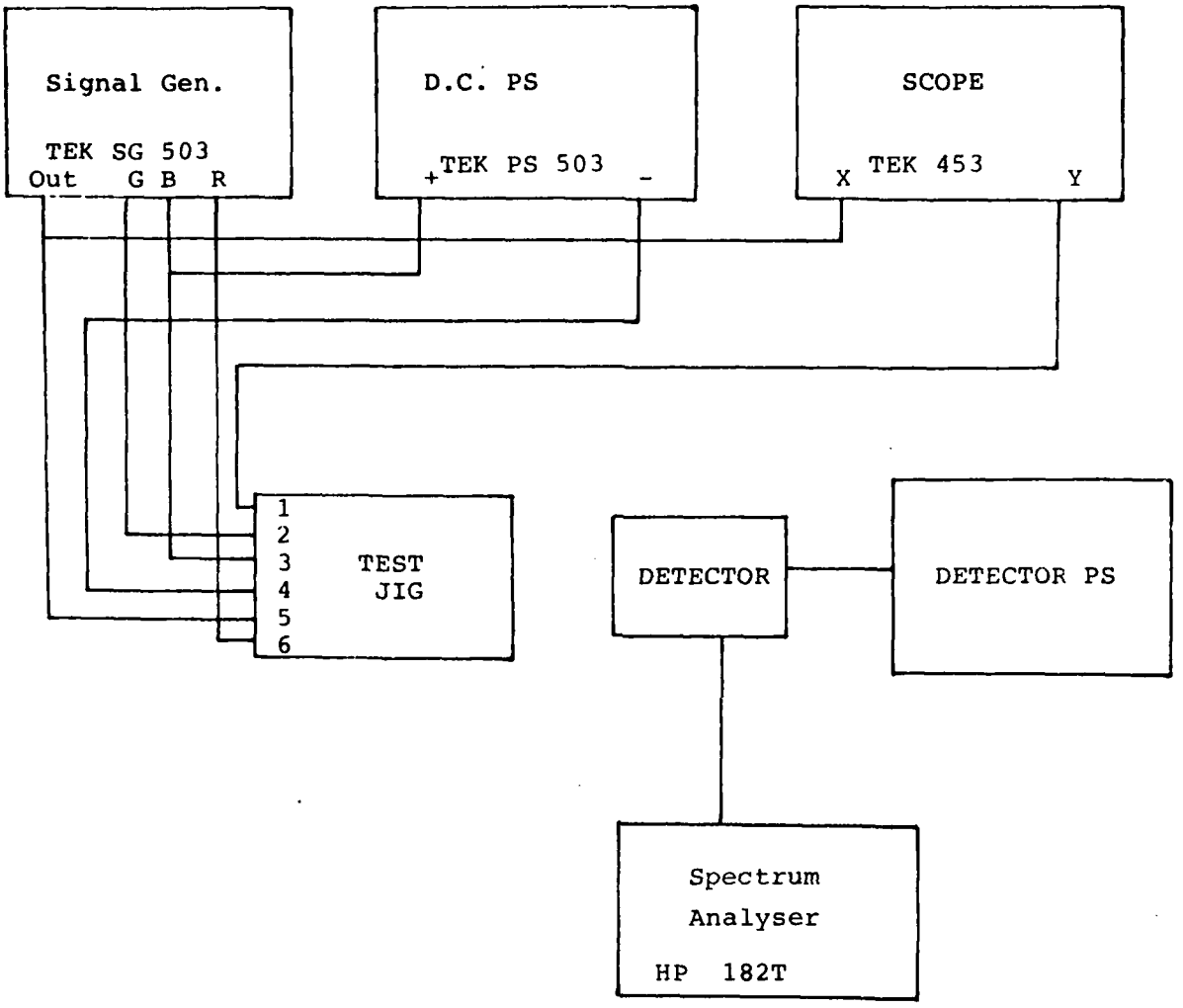


Figure 64 - Linearity Trace.



DRAFTSMAN	DATE	NAME	
APPROVED	DATE	FIGURE 65 LINEARITY TEST	LASER DIODE LABORATORIES INCORPORATED 1130 Somerset St New Brunswick N J 08901
MAT'L		SCALE	LDL FSCM 57417
		DWG SIZE	PART NO

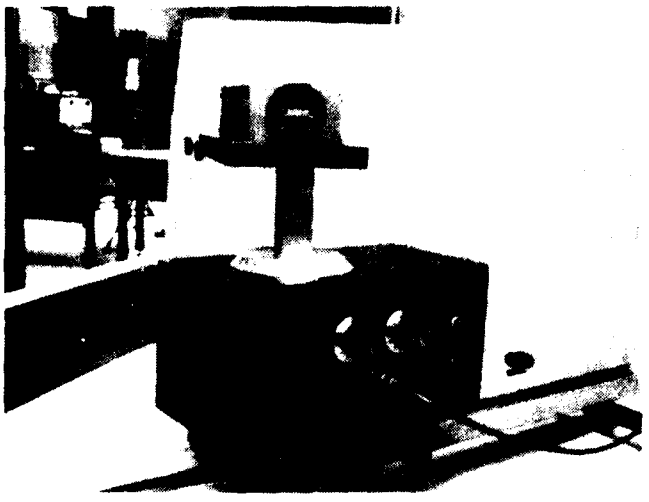


Figure 66 - Photograph of Goniometer Showing Rotatable Head.

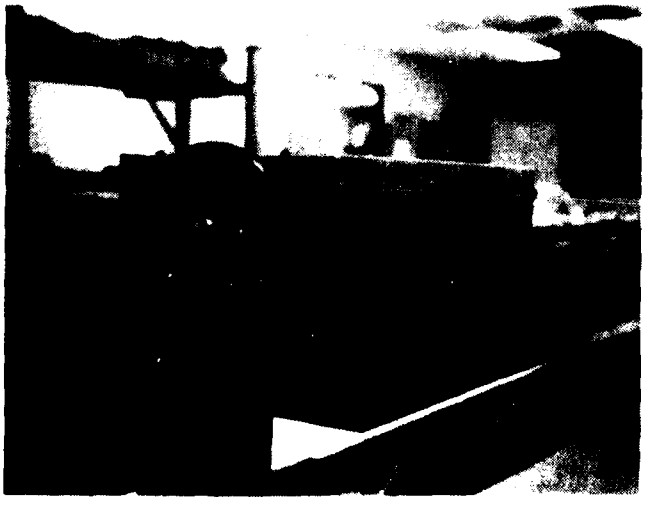


Figure 67 - Photograph of Goniometer Showing Close-Up of Mounting Fixture.

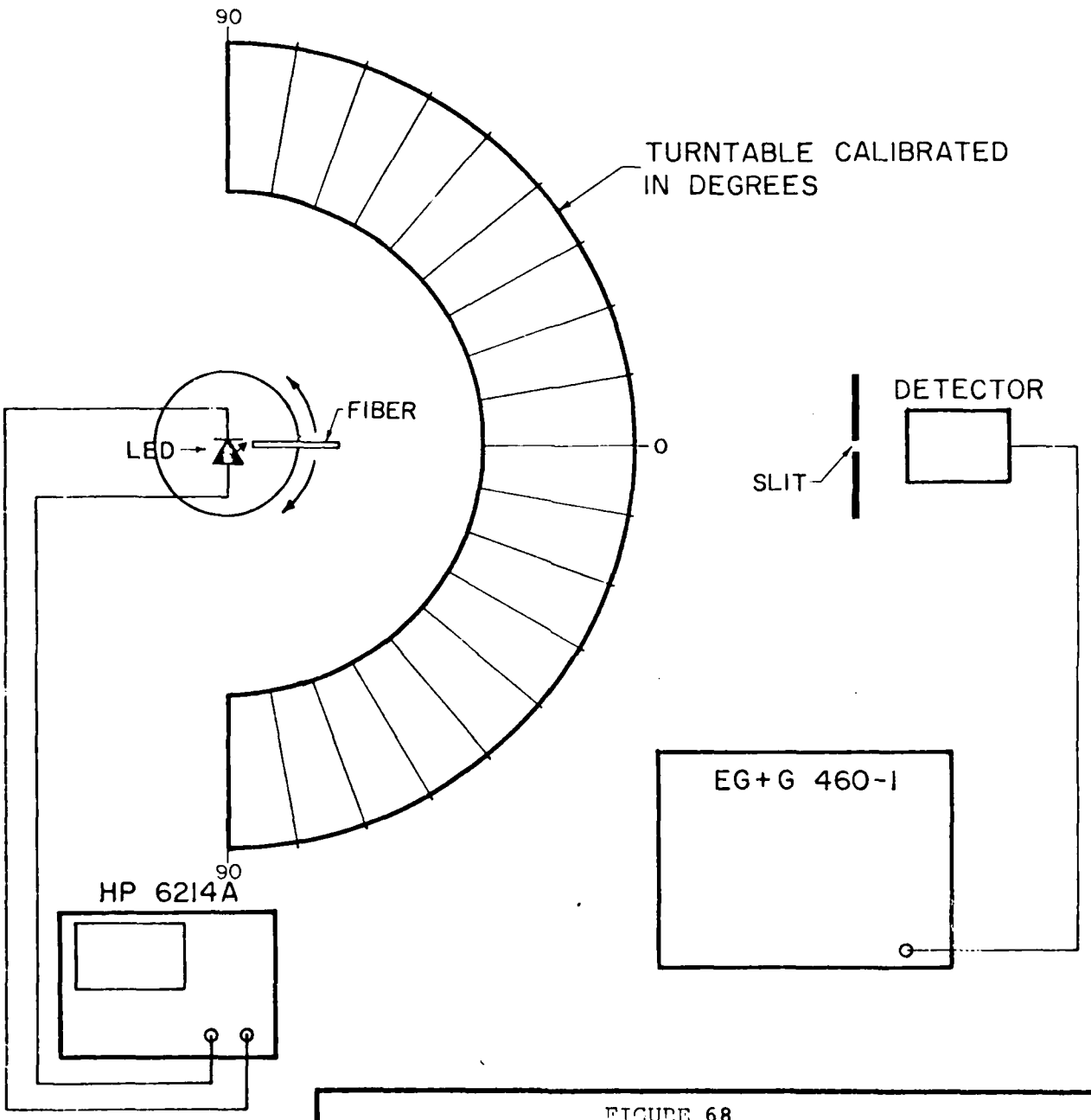


FIGURE 68

NUMERICAL APERTURE TEST

SCALE:	APPROVED BY	DRAWN BY R. JOBES
DATE: 9/20/77		
		DRAWING NUMBER

DIETZGEN MASTER FORM 198MF

SECTION IV

SUMMARY OF PILOT LINE TEST RESULTS

(8135)

TESTING CYCLE

TESTING CYCLE CONSISTED OF:

PROCESS CONDITIONING

PRE-BURN-IN ELECTRICAL

BURN-IN (168 HRS.)

POST BURN-IN ELECTRICAL

GROUP A INSPECTION

GROUP B INSPECTION

GROUP C INSPECTION

ENVIRONMENTAL TESTS PERFORMED AT:

AMERICAN ELECTRONICS LABORATORY
LANSDALE, PA

FIGURE 69 - TESTING CYCLE

FIGURE 70

FLOW CHART - FIRST ARTICLE (50 Pcs.)

(8135)

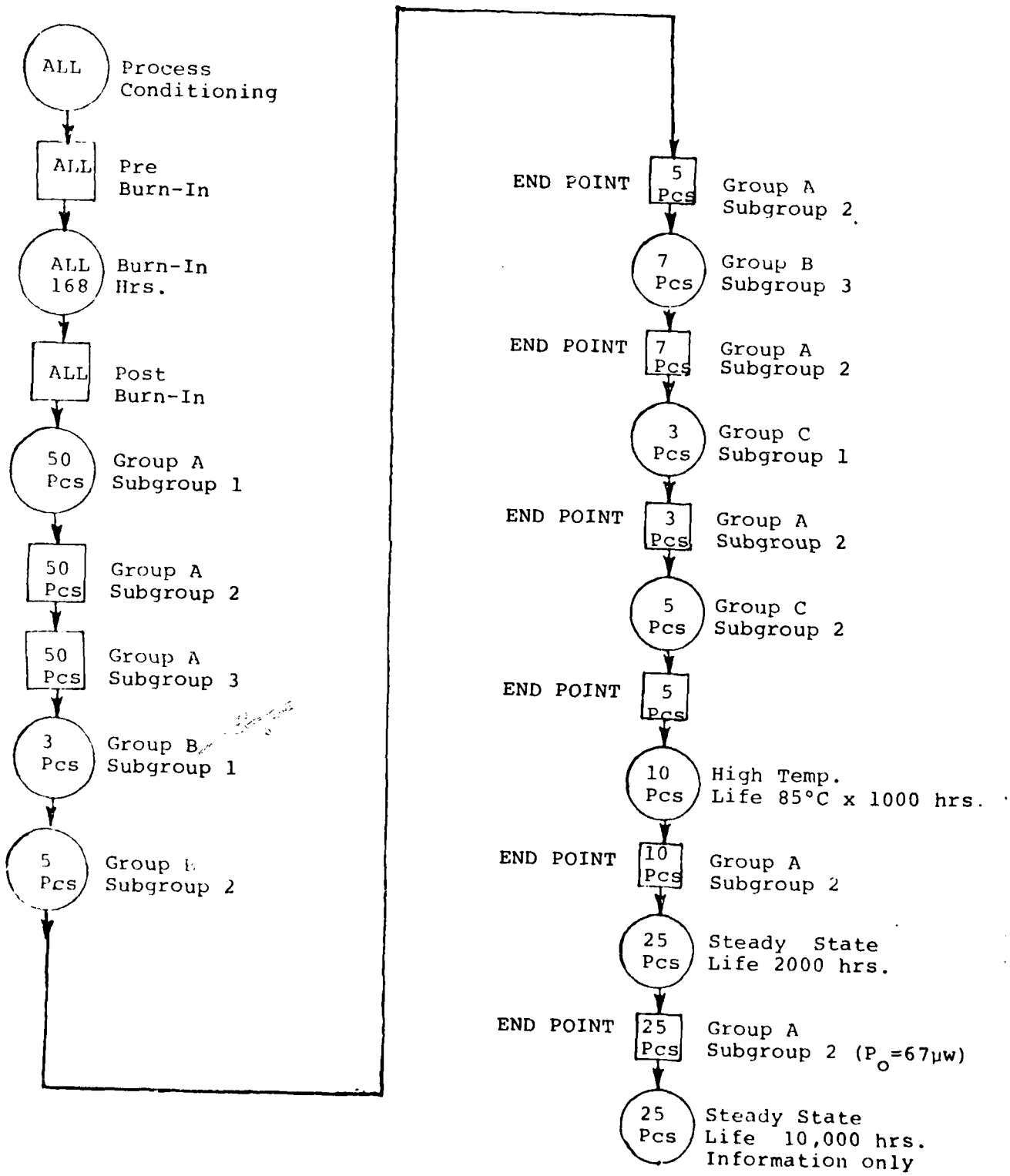
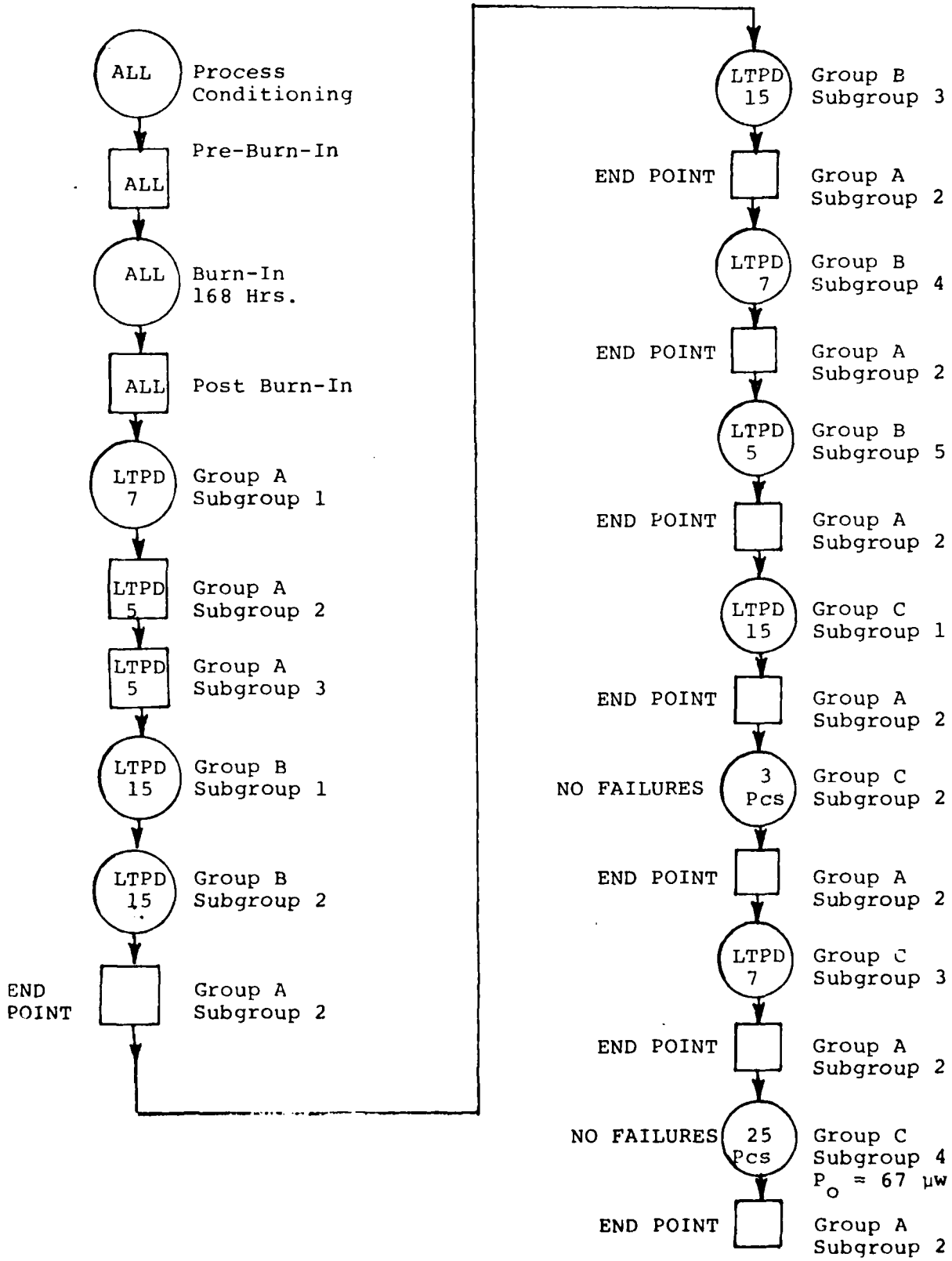


FIGURE 71

FLOW CHART - PRODUCTION TESTING

(8135)



(8135)

TABLE 4

PROCESS CONDITIONING - ALL UNITS

TEST	CONDITIONS MIL-STD.	METHOD	REQUIREMENTS	TYP. RES.
High Temperature Life	750	1031	85°C x 48hrs.	PASS
Thermal Shock	202	107/A	t_r=-40°C t_H=85°C	PASS
Constant Acceleration	750	2006	1000 6 directions	PASS
PRE BURN-IN				
Peak Wavelength		800-890nm		830±10nm
V_f	750	4011	1.9V@20mA max.	1.55±.05V
V_{BR}	750	4021	3.0V@10μA min.	>3.0V
Output Power 25°C		75μW @ I_F = 100mA min.		100μW(typ)175μW(ma:
BURN-IN		168hrs. @ I_F = 100mA		
POST BURN-IN				
Peak Wavelength		800-890nm	Δλ = 5% max.	830±10nm
V_f	750	4011	1.9V max.	1.55±.05V
V_{BR}	750	4021	3.0V min.	>3.0V
Output Power 25°C		75μW@I_F = 100mA min:	ΔPo=5% max.	100μW(typ)175μW(ma:

(8135)

DEVICE PLACED IN RTV MOLD
FITTED TO FIXTURE

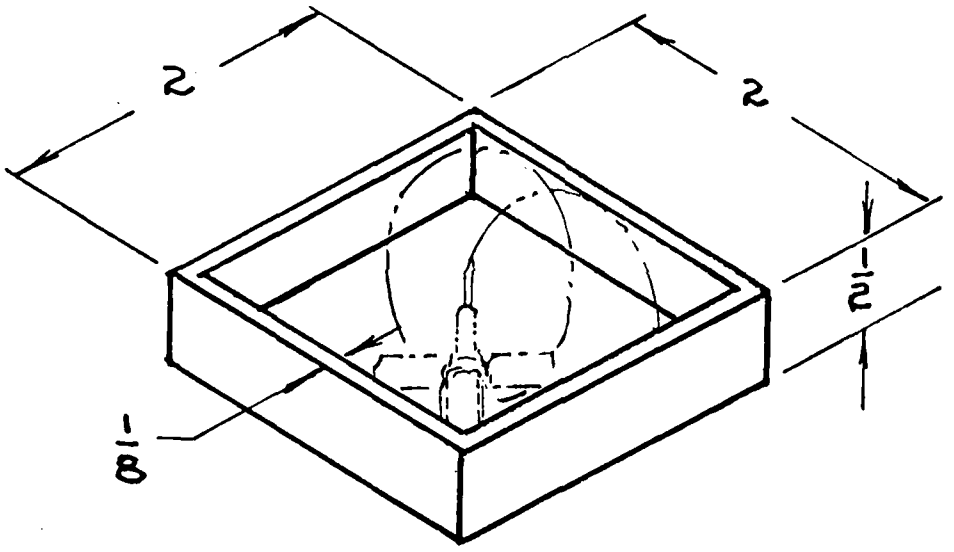


FIGURE 72
ACCELERATION FIXTURE

(8135)

TABLE 5 - TESTING

GROUP A

TEST	CONDITIONS MIL-STD	METHOD	REQUIREMENTS	TYP. RES.
SUBGROUP 1				
Visual & Mechanical	750	2071	-	PASS
Terminal Strength (fiber)	750	2036A	10 Newtons min.	PASS
SUBGROUP 2	END POINT TESTS			
Peak Wavelength	845±45nm			830±10nm
V_f	750	4011	1.9V@I_F=100mA max.	1.55±.05V
V_{BR}	750	4021	3.0V@I_r=10μA min.	>3.0V
Output Power 25°C	75μW @ I_F = 100mA min.			100μW typ. 175μW max.
SUBGROUP 3				
Spectral Width	50nm @ 3db of intensity (max)			46-48nm
Bandwidth	32MH$_z$ @ I_p = ±50mA + 100mA DC bias			(20-27) TYP=22
Numerical Aperture	0.2 @ I_F = 100mA			0.16
Rise & Fall Time	20ns @ I_p = 100mA, + 5mA bias (max)			(13-18) Typ=16
Linearity	26db @ I_p = ±50mA, + 100mA dc bias			30(typ), 33(max)

(8135)

TABLE 6 - TESTING

GROUP B

TEST	MIL-STD	METHOD	CONDITIONS REQUIREMENTS	TYP. RES.
SUBGROUP 1				
Physical Dimensions	750	2071		PASS
SUBGROUP 2				
Solderability	750	2026		PASS
Thermal Shock	750	1051	A-10cycles t_r=-40°C t_H=85°C	PASS
End Point	GROUP A	SUBGROUP 2		No Change
SUBGROUP 3				
Shock	750	2016	500g 0.5ms	PASS
Vibration Fatigue	750	2046	-	PASS
Vibration, V.F.	750	2056	-	PASS
Constant Acceleration	750	2006	1000g 6 directions	PASS
End Point	GROUP A	SUBGROUP 2		PASS
SUBGROUP 4				
High Temp. Life	750	1032	85°Cx340hrs.	PASS
End Point	GROUP A	SUBGROUP 2		No Change
SUBGROUP 5				
Steady State Life	750	1027	I_F=100mA:340hrs.	100µW typ.
End Point	GROUP A	SUBGROUP 2		175µW max.

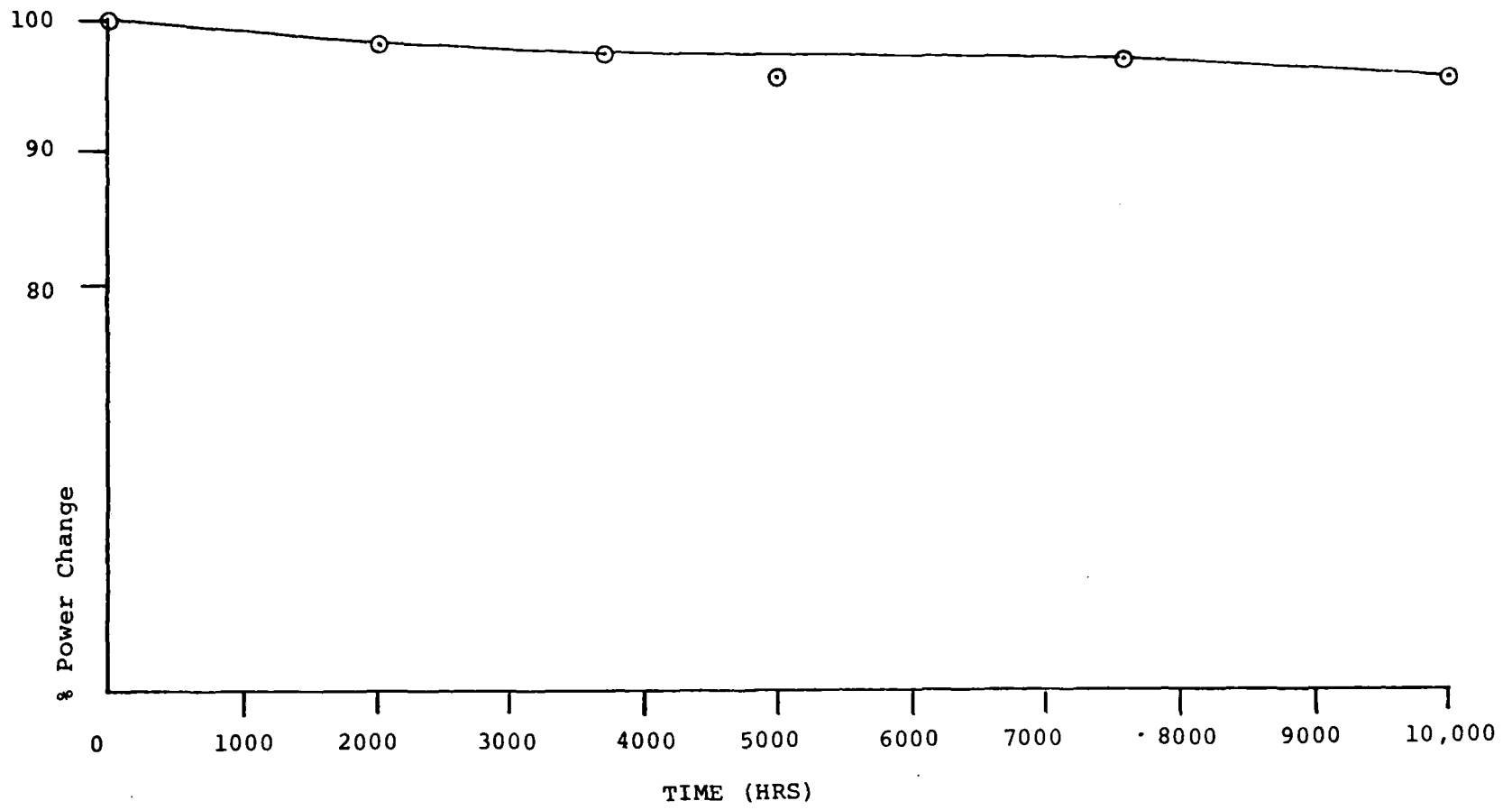
FOR FIRST ARTICLE: SUBGROUPS 1,2&3 ONLY

(8135)

TABLE 7 - TESTING
GROUP C

TEST	MIL-STD	METHOD	REQUIREMENT	TYP. RES.
SUBGROUP 1				
Thermal Shock	750	1051	A_1-25cycles t_r=-40°C t_H=85°C	PASS
End Point	GROUP A	SUBGROUP 2		PASS
SUBGROUP 2				
Solvent Resistance	202	215		PASS
End Point	GROUP A	SUBGROUP 2		PASS
SUBGROUP 3				
High Temp. Life	750	1031	85°Cx1000hrs.	PASS
End Point	GROUP A	SUBGROUP 2		No Change
SUBGROUP 4				
Steady State Life	750	1026	I_f=100mA:2000hrs.	100µW typ.
End Point	GROUP A	SUBGROUP 2 except P_o = 67µW		175µW max.

FIG. 73 - 10,000 HR. LIFE TEST (8135)



SECTION V

PILOT LINE RATE REPORT

PROCESS	YIELD %	DEVICES REQ'D.	RATE/HR.		
Deliver Devices		250			
Final Electrical Test	90	275	50		
Burn-In	100	275			
Pre Burn-In Electrical	80	330	50		
Environmental Test	100	330			
Align Fiber, Epoxy	95	347	20		
Assemble Fiber-Ferrule	85	400	20		
Wire Bond Chip	95	419	48		
Chip Mourt	80	502	75		

TABLE 8 - PILOT LINE RATES

SECTION VI

VOLUME PRODUCTION PLAN

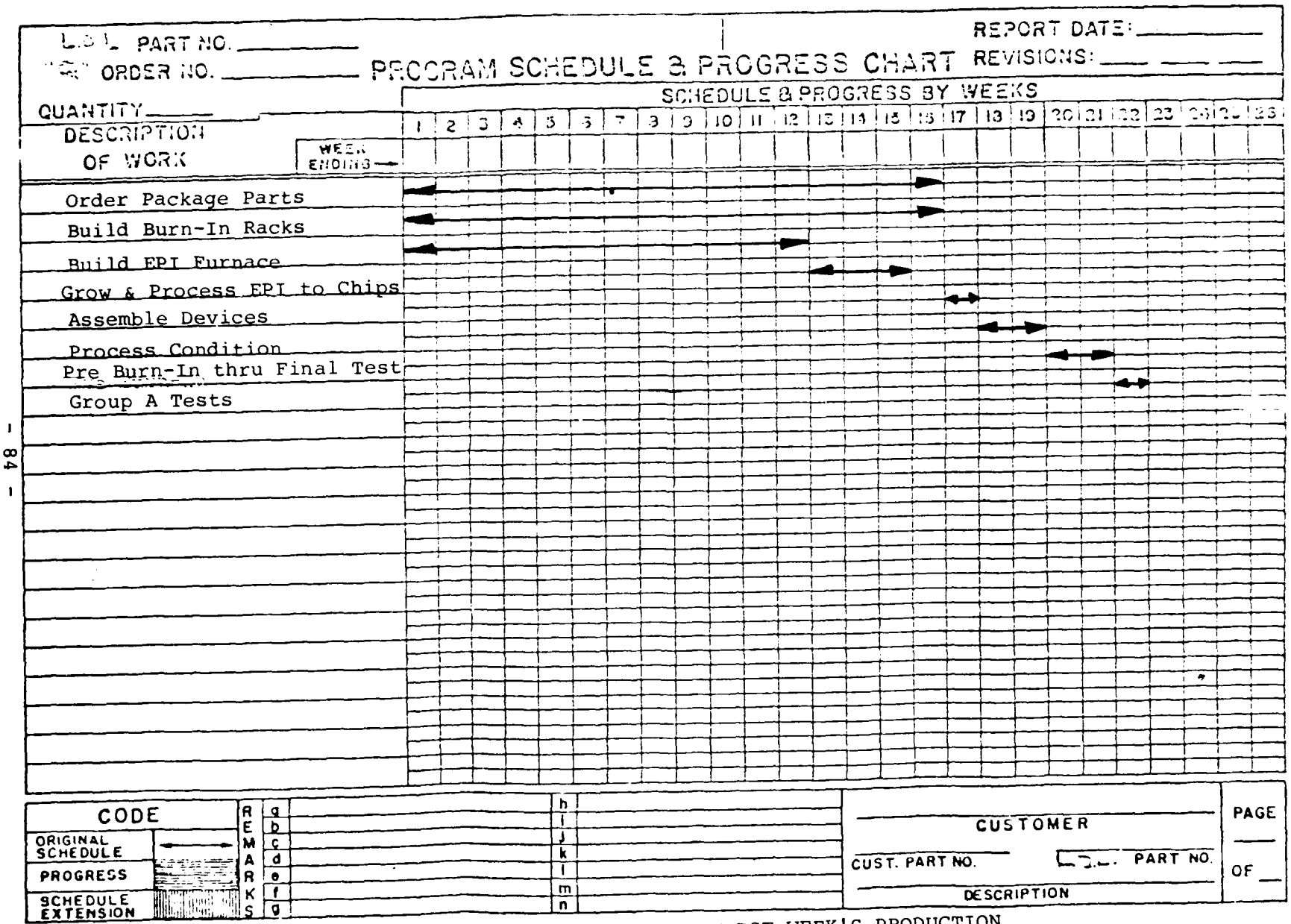


TABLE 9 - VOLUME PRODUCTION SCHEDULE FOR FIRST WEEK'S PRODUCTION

PROCESS STEP	YIELD %	DEVICES/WK	RATE/HR	REQ'D/HR	PEOPLE REQ'D
DELIVER DEVICES		2553			
FINAL ELECTRICAL TESTS	90	2808	50	70	1.4
BURN-IN	100	2808			
PRE BURN-IN ELECTRICAL	80	3369	50	84	1.7
ENVIRONMENTAL TESTS	100	3369			
ALIGN FIBER, EPOXY	95	3538	20	88	4.4
ASSEMBLE FIBER-FERRULE	85	4069	20	102	5.1
WIRE BOND CHIP	95	4273	48	107	2.2
CHIP MOUNT	90	4700	75	118	1.6

TABLE 10 - VOLUME PRODUCTION RATES

TABLE 11

ADDITIONAL VOLUME PRODUCTION REQUIREMENTS

EPITAXIAL REQUIREMENTS

Diode Chips Required per Week	4700
Maximum Number Chips per Wafer	945
Number Good Electrical Chips per Wafer	500
Number Wafers required @ 80% Yield	11

EQUIPMENT REQUIREMENTS

2630	Burn-In Positions	@ $ 150.00	per Position
5	Assembly Stations	@ $ 4,000.00	per Station
2	Epitaxial Furnaces	@ $22,000.00	
	Power Measurement Test Set	$10,000.00	

PERSONNEL REQUIREMENT

Engineers	2
Technicians	2
Assembly	17

AD-A101 480 LASER DIODE LABS INC NEW BRUNSWICK NJ F/G 9/1
LIGHT EMITTING DIODES FOR FIBER OPTIC COMMUNICATIONS.(U)
MAR 81 A GENNARO DAAB07-76-C-A135
UNCLASSIFIED CORADCOM-76-8135-F NL

2 OF 2
AD A101480

END
DATE FILMED
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DTIC

APPENDIX A

PRODUCT CAPABILITY DEMONSTRATION

LASER DIODE LABORATORIES, INC

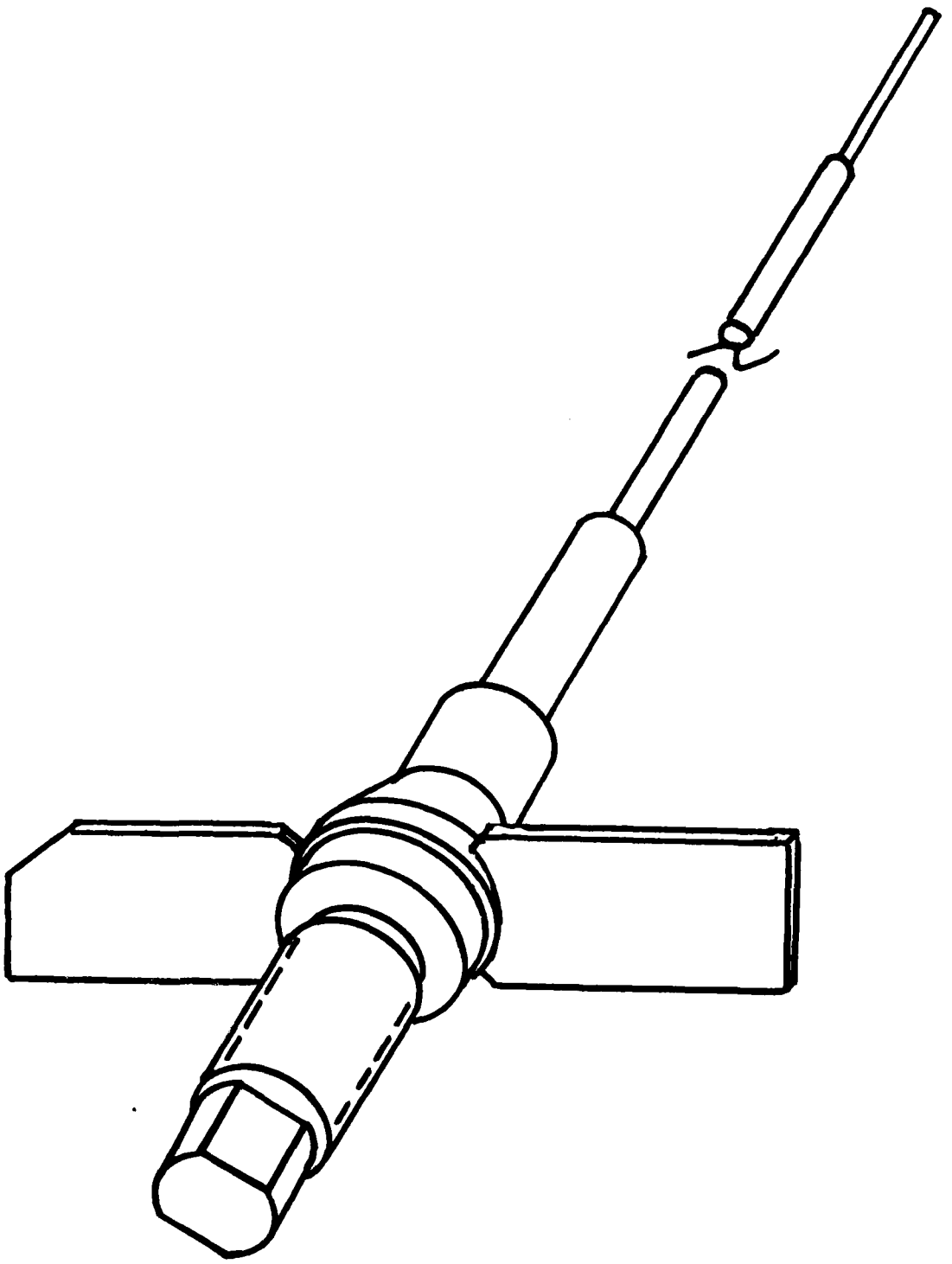
U. S. ARMY CORADCOM PRODUCT CAPABILITY DEMONSTRATION

CONTRACT DAAB07-76-C-8135

CONTRACT DAAB07-76-C-0040

FEBRUARY 18, 1981

9:00 A.M.	-	Welcoming Session (Holiday Inn)	- T. Stockton
9:30 A.M.	-	Technical Presentation Program #8135	
	-	Diode Specifications	- T. Stockton
	-	Diode Chip Concepts	- T. Stockton
	-	Packaging and Assembly Concepts	- A. Gennaro
	-	Testing Methods	- S. Lerner
10:45 A.M.	-	Coffee - Q & A Period	
11:00 A.M.	-	Technical Presentation Program #0040	
	-	Diode Specifications	- A. Ceruzzi
	-	Diode Chip Concepts	- A. Ceruzzi
	-	Packaging and Assembly Concepts	- A. Gennaro
	-	Testing Methods	- S. Lerner
		Q & A Period	
12:00 P.M.	-	Lunch	
1.00 P.M.	-	Transport to LDL (Provided)	
1:30 P.M.	-	Tour of LDL Facilities	
	-	Demonstration of Diodes	
2:30 P.M.	-	Transport to Holiday Inn (Provided)	



CONTRACT DAAB07-76-C-8135

FIBER COUPLED LED

U. S. ARMY CORADCOM SPECIFICATION DAAB07-76-C-8L35
PRODUCT CAPABILITY DEMONSTRATION FEBRUARY 18, 1981

OBJECTIVES

GENERAL MM&T PROGRAM OBJECTIVES

THE ESTABLISHMENT OF THE MANUFACTURING PROCESS, TECHNIQUES OR EQUIPMENT TO ENSURE EFFICIENT PRODUCTION OF CURRENT OR FUTURE DEFENSE PROGRAMS.

SPECIFIC OBJECTIVES

DEVELOP AND DEMONSTRATE A FIBER COUPLED LED CAPABLE OF 75 μW OUTPUT POWER AT 820 NM.

LASER DIODE LABORATORIES, INC

CONTRACT GOALS (LOGISTICS)

* ESTABLISH MANUFACTURING METHODS AND PROCESSES.
* ENGINEERING, CONFIRMATORY AND PILOT PRODUCTION PHASES.
* PILOT PRODUCTION CAPABILITY OF 250 DEVICES.

LASER DIODE LABORATORIES, INC.

CONTRACT GOALS (TECHNICAL)

* ETCHED WELL EMITTER
* 75 μW FIBER POWER OUTPUT
* CO-AXIAL PACKAGE
* ENVIRONMENTAL CAPABILITY

LASER DIODE LABORATORIES INC

PROBLEMS ENCOUNTERED AND SOLVED

* ETCHED WELL PHOTO MASK PROCESS.

* PACKAGE DESIGN FOR FIBER ATTACHMENT.

* EPOXIES FOR PACKAGE AND FIBER ASSEMBLY.

*MECHANICAL STRENGTH OF PACKAGE

LASER DIODE LABORATORIES, INC

PRODUCTION CAPABILITY DEMONSTRATION

REGISTER - FEBRUARY 18, 1981

NAME:	COMPANY:
J. EIDE	ITT
B. HAWKINS	SPECTRONICS DIV., HONEYWELL
JACK HUNTER	CORADCOM U.S. ARMY
LOUIS CORYELL	CORADCOM U.S. ARMY
AL FEDDELER	U.S. ARMY CORADCOM
TED APPLE	CORADCOM
MARK D. SKELDON	NIGHT VISION LABS
LEN FELDBERG	BURNDY CORP.
DAN DAPKUS	ROCKWELL INTERNATIONAL
LOU TOMASETTA	ROCKWELL
GEORGE IRISH	GTE SYLVANIA
MARCUS GARVEY	GTE SYLVANIA
C.J. HWANG	GENERAL OPTRONICS
JOSEPH F. SVACEK	GENERAL OPTRONICS
KEN PEFFLEY	OIS
M. ETTENBERG	RCA
BOB GILL	LDL President
PETE SCHNEIDER	LDL Executive Vice President
TOM STOCKTON	LDL Vice President E & D
STEVE KLUNK	LDL Sales Engineering Manager
RICHARD KLEIN	LDL Marketing Manager
AL GENNARO	LDL Manager Special Products
ALEX CERUZZI	LDL Manager Development Engineering
ROLLIN BALL	LDL Supervisor E & D
ANDY KAN	LDL Manager E/O Engineering
STEVE LERNER	LDL Manager Quality Assurance

APPENDIX B

SCS-511 Specifications

LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

1. SCOPE

1.1 Scope.- This specification covers the detail requirements for Gallium Aluminum Arsenide (GaAlAs) light emitting diode (LED) devices having a wavelength of 820 nanometers (nm), compatible with fiber optic cables and systems employing the use of fiber optics.

1.2 Maximum operating conditions:-

I_F = 150 mA

V_r = 3.0 V

I_r = 10 μA

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on the date of invitation for bids or request for proposals, forms a part of this specification to the extent specified herein:

SPECIFICATION

MILITARY

MIL-S-19500 Semiconductor Devices, General Specification for.

STANDARDS

MILITARY

MIL-STD-202 Test Methods for Electronic and Electrical Component Parts.

MIL-STD-750 Test Methods for Semiconductor Devices.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Both title and number or symbol should be stipulated when requesting copies.)

2.2 Other publications.- The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

Laser Parameter Measurements Handbook, by H. G. Heard.

(Application for copies should be addressed to John Wiley & Sons, Inc., New York, N.Y.)

3. REQUIREMENTS

3.1 General description.- The LED devices are heterojunction devices used at a high data rate at a wavelength compatible for fiber optic cables. The device shall have an optical output and be optimized for a wavelength of 820 nm. fiber

3.2 Performance characteristics.- Performance characteristics shall be as specified in Tables III, IV and V and as follows:

3.2.1 Radiant intensity.- Radiant intensity of the unit, prior to the attachment of the optical fiber, shall be a minimum of 2 mW/Sr (See 4.6.3).

3.2.2 Linear source size.- The linear source size of the unit, prior to the attachment of the optical fiber, shall be a minimum of 50 µm and a maximum of 55 µm. (See 4.6.2).

3.2.3 Process conditioning.- All units shall be process conditioned. (See Table I and 4.5.1).

3.2.4 Linearity.- With a fundamental of 1 MHz the second harmonic shall be at least 35 db down from the fundamental.

3.2.5 Burn-in.- All units shall be burned-in. (See 4.5.2).

3.3 Design, construction and physical dimensions.- The design, construction and physical dimensions shall be as specified in Figure 1 and herein.

3.3.1 Lead material and finish.- Lead material shall be Kovar or alloy 42 with a hot solder dip finish.

3.3.2 Metals.- External metal surfaces shall be corrosion resistant or shall be plated or treated to resist corrosion.

3.4 Marking.- Marking shall be in accordance with MIL-S-19500 except the following information shall be marked on each unit.

(a) Date code.
(b) Manufacturer's identification.
(c) Part number: SCS-511.
(d) Power output in mW at I_F = 100 mA.

3.5 Resistance to solvents.- When the device is subjected to solvents, there shall be no evidence of: (a) mechanical or electrical damage, (b) deterioration of the materials or finishes, and (c) illegibility of case marking.

3.6 Solderability.- Leads shall be solderable.

3.7 Thermal shock.- After being subjected to specified temperature cycling, there shall be no evidence of defects or damage to case, leads, or seals or loss of marking legibility.

3.8 Shock.- After being subjected to a shock of 500g for .5 msec, there shall be no evidence of defects or damage to leads or seals. Also, the device shall be electrically operable (see Subgroup 2 of Table III).

3.9 Vibration fatigue.- After being subjected to a vibration with a constant peak acceleration of 20g minimum and a frequency of 60 ± 20 Hz for at least 32 ± 8 hours, there shall be no evidence of defects or damage to case, leads or seals. Also, the device shall be electrically operable (see Subgroup 2 of Table III).

3.10 Vibration, variable frequency.- After being subjected to a vibration with a constant peak acceleration of 20g minimum and a frequency range between 100 and 2000 Hz, there shall be no evidence of defects or damage to case, leads, or seals. Also, the device shall be electrically operable (see Subgroup 2 of Table II

3.11 Constant acceleration.- After being subjected to a constant acceleration of 1000g for 1 minute in each of its orientations, there shall be no evidence of defects or damage to case, leads, or seals. Also, the device shall be electrically operable (see Subgroup 2 of Table III).

3.12 High temperature life.- After being stored at 85°C for the specified time there shall be no evidence of defects or damage to case, leads or seals or loss of marking legibility. Also, the device shall be electrically operable (see Subgroup 2 of Table III).

3.13 Steady state operation.- After being subjected to steady state operation (I_F = 100 mA) for the specified temperature and time, the device shall be electrically operable (see Subgroup 2 of Table III).

3.14 Moisture resistance.- After being subjected to the specified humidity and temperature cycling, there shall be no evidence of corrosion of external metal surfaces. Also, the device shall be electrically operable (see Subgroup 2 of Table III).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection.- Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection.- Inspection shall be classified as follows:

(a) First article inspection (does not include preparation for delivery). (See 4.4).
(b) Quality conformance inspection. (See 4.5).

4.3 Test plan.- The contractor prepared Government-approved test plan, as cited in the contract, shall contain:

(a) Time schedule and sequence of examinations and tests.
(b) A description of the method of test and procedures.
(c) Identification and brief description of each inspection instrument and date of most recent calibration.

4.4 First article.- Unless otherwise specified in the contract, the first article inspection shall be performed by the contractor.

4.4.1 First article units.- The contractor shall furnish 50 samples for first article inspection.

4.4.2 First article inspection.- The first article inspection shall consist of Table II and all the tests included in the Government-approved test plan (see 4.3), to show compliance with the requirements of Section 3. No failures shall be permitted.

4.4.2.1 Order of testing.- Prior to first article inspection, all units shall have been process conditioned followed by burn-in.

4.5 Quality conformance inspection.- Quality conformance inspection shall consist of the examinations and tests specified for Group A inspection (Table III), Group B inspection (Table IV), and Group C inspection (Table V). The following shall apply:

(a) Prior to performing Group A inspection, all units shall be subjected to the tests specified in paragraphs 4.5.1 and 4.5.2.
(b) If the manufacturer chooses the following option(s) for testing, the sample units that are to be used in Group C inspection shall be designated as such prior to conducting the referenced Group B tests. Moreover, the number of failed diodes to be counted for lot acceptance or rejection as a result of Group C test shall be equal to all failed diodes of the test in Group B inspection, which were predesignated for use in Group C inspection, plus any additional failures occurring during Group C testing.

(1) For subgroup 3 life test in Group C inspection, the manufacturer has the option of using all or a portion of the sample already subjected to 340 hours of Group B life testing for an additional 660 hours of testing to meet the 1,000 hour requirement.

(2) For the thermal shock (temperature cycling) test of Group C inspection, the manufacturer has the option of using all or a portion of the sample already subjected to 10 cycles of Group B thermal shock (temperature cycling) testing for an additional 15 cycles of testing to meet the 25-cycle requirement.

4.5.1 Process conditioning.- Process conditioning shall be performed on 100 percent of the units. The measurements and sequence shall be as specified in Table I.

4.5.2 Burn-in.- Burn-in shall be performed on 100 percent of the units for 168 hours minimum under the following conditions:

$T_a = 25°C$

$I_F = 100$ mA

4.5.2.1 Pre-burn-in measurements.- Prior to burn-in, measurement of the parameters listed in subgroup 2 of Table III shall be performed on 100% of the units at $T_a = 25°C$.

4.5.2.2 Post burn-in measurements.- Post burn-in measurements, listed in subgroup 2 of Table III, shall be performed within 8 hours of the removal of bias conditions (i.e. I_F, I_R) at 25°C. The values observed for each device shall not exceed the following, relative to the pre-burn-in measurements:

$\Delta P_{opt} = 1\%$

$\Delta \eta_P = 1\%$

Table I.- Process conditioning

Test	MIL-STD	Method No.	Details
High temperature life (non-operating)	750	1031	Storage temperature = 85°C Storage time = 48 hours min
Thermal shock	202	107	Test Condition A except t(high) = 85°C; t(low) = 40°C; time at temperature extremes = 15 minutes maximum
Constant acceleration	750	2006	1,000 g

Table II.- First article inspection

Test	Reqt Para	Method	No. of samples 2/				
			3	5	7	10	25
Group A inspection	as specified	Table III 1/	To be performed on all units.				
Group B inspection	as specified	Table IV 1/					
Subgroup 1			X				
Subgroup 2				X			
Subgroup 3					X		
Group C inspection	as specified	Table V 1/					
Subgroup 1			X				
Subgroup 2				X			
High temperature life	3.12	Method 1031 of MIL-STD-750 T_a = 85°C for 1000 hrs				X	
Steady state operation life	3.13	Method 1026 of MIL-STD-750 T_a = 25°C for 2000 hrs 3/ I_F = 100 mA					X

1/ LTPD values do not apply for first article inspection.

2/ No. of samples specified for each column shall be subjected to all the tests of that column.

3/ After 2000 hours, the P_{opt} shall equal to be specified.

Table III.- Group A inspection
T_a = 25°C ± 5°C unless otherwise specified

Test	Condition	Test Method	Min	Max	Units	LTPD
Subgroup 1						7
Visual and mechanical inspection		Method 2071 of MIL-STD-750	See 3.3			
Terminal strength of optical fiber	Test Condition A	Method 2036 of MIL-STD-750	10		Newtons	
Subgroup 2						5
Peak emission wavelength	I_F = 100 mA	Para. 4.6.4	800	830	nm	
Forward voltage	I_F = 20 mA	Method 4011 of MIL-STD-750		1.9	V	
Reverse breakdown voltage	I_r = 10 µA	Method 4021 of MIL-STD-750	3.0		V	
Output optical power	I_F = 100 mA	Para. 4.6.8	.100		mw	
Subgroup 3						5
Spectral width (3 db of intensity)	I_F = 100 mA	Para. 4.6.5	40	45	nm	
Bandwidth	I_p = ±50 mA +100 mA dc bias	Para. 4.6.7	32	44	MHz	
Numerical aperture	I_F = 100 mA	Para. 4.6.9		0.3		
Rise and fall time	I_p = 100 mA +5 mA dc bias 50 ohm system	Para. 4.6.6	10	20	ns	
Thermal impedance		Para. 4.6.10		20°	C/W	
Linearity	I_p = ±50 mA +100 mA dc bias	Para. 4.6.11		See 3.2.4		

Table IV.- Group B inspection

Test	Reqt Para	MIL-STD-750 Method	Conditions	LTPD
Subgroup 1				15
Physical dimensions	3.3	2071	See Figure 1	
Subgroup 2				15
Solderability 1/	3.6	2026		
Thermal shock (temperature cycling)	3.7	1051	Test Condition A except t(high) = 85°C; t(low) = -40°C 10 cycles; time at temperature extreme - 15 minutes maximum	
Moisture resistance	3.3.2,	1021		
End point measurements: Subgroup 2 of Table III	3.14			
Subgroup 3				15
Shock	3.8	2016	Non-operating, 500 g .5 ms	
Vibration fatigue	3.9	2046	Non-operating	
Vibration, variable frequency	3.10	2056	Non-operating	
Constant acceleration	3.11	2006	force applied = 1,000 g	
End point measurements: Subgroup 2 of Table III				
Subgroup 4				7
High temperature life (non-operating) See 4.5(b)	3.12	1032	T_a = 85°C	
End point measurements: Subgroup 2 of Table III				
Subgroup 5				5
Steady state operation life	3.13	1027	I_F = 100 mA at 25°C	
End point measurements: Subgroup 2 of Table III				

1/ All devices must have been through the temperature/time exposure in burn-in. The LTPD applies to the number of leads inspected except in no case shall less than 3 devices be used to provide the number of leads required.

Table V.- Group C inspection

Test	Reqt Para	MIL-STD-750 Method	Details	LTPD
Subgroup 1				15
Thermal shock (temperature cycling) (See 4.5(b))	3.7	1051	Test Condition A_1 except t(high) = 85°C t(low) = -40°C time at temperature extremes = 15 minutes, min; total test time = 72 hrs,max	
End point measurements: Subgroup 2 of Table III				
Subgroup 2				
Resistance to solvents (See 4.6.1)	3.5	Method 215 of MIL-STD-202		3 devices (no failures)
End point measurements: Subgroup 2 of Table III				
Subgroup 3				7
High temperature life (non-operating) (See 4.5(b))	3.12	1031	T_a = 85°C for 1000 hours	
End point measurements: Subgroup 2 of Table III				
Subgroup 4				
Steady state operation life	3.13	1026	I_F = 100 mA T_a = 25°C for 2,000 hours	25 devices (no failures)
End point measurements: Subgroup 2 of Table III.				

1/ Limits of subgroup 2 Table III same except: P_{opt} = to be specified.

4.6 Test methods and conditions.- Conditions and methods of examination and test shall be as specified in Tables I, II, III, IV and V and as follows:

4.6.1 Resistance to solvents.- Resistance to solvents shall be performed in accordance with Method 215 of MIL-STD-202.

4.6.2 Linear source size.- The linear source size can be determined by using a microscope objective and a normal lens (for projection) combination with a magnification of at least 200X. The image shall be scanned in both vertical and horizontal directions with a calibrated silicon photodiode detector (See 6.5) masked with a 0.5 mm slit. The slit shall be positioned perpendicular to the direction scanned. The relative intensity shall be measured until it falls to 90% of its peak value. These boundaries will define the linear source size. (See Figure 2).

4.6.3 Radiant intensity (I).- The unit (driven at I_F = 100 mA) is placed a distance of approximately 1.58 centimeters from a calibrated silicon photodiode detector which is masked to a circular area (A) with a radius of 0.5 cm. The optical power output of the unit is then measured and the radiant intensity (see 6.2) is calculated. (See Figure 3).

4.6.4 Peak emission wavelength (λ_p).- Peak emission wavelength shall be measured using a grating spectrometer with a resolution of at least one angstrom.

4.6.5 Spectral width (3 db of intensity).- The spectral width, to its 3 db of intensity points, shall be measured using a grating spectrometer with a resolution of at least 10 Å.

4.6.6 Rise and fall time (t_r, t_f).- An input of 100 mA peak to peak, with a rise and fall time of 5 ns maximum is applied to the unit. The optical output pulse is then recorded.

4.6.7 Bandwidth.- A 100mA peak to peak RF wave with a 100 mA dc bias is applied to the input of the unit. Keeping the input drive current constant, the frequency of the input signal is varied. Measure light output with a silicon photodiode detector to locate the 3 db intensity points to determine bandwidth.

4.6.8 Optical output power (P_{opt}).- A calibrated silicon photodiode detector shall be used to measure the optical output power of the unit. (See 6.5). The distance between the photodiode and the fiber end shall be as small as possible.

4.6.9 Numerical aperture (N.A.).- The numerical aperture of the optical fiber output shall be determined. Using a calibrated silicon photodiode detector (see 6.5) on a turntable, the detector is rotated through a half angle Θ until the relative intensity of power output falls to 90% of its peak value. (See 6.3).

4.6.10 Thermal impedance.- With the device mounted on a heat sink capable of being heated above room temperature, it is driven at a (0.1%) duty cycle to minimize self-heating effects. Measurement of peak output wavelength versus temperature from 20°C to 70°C are recorded. In order to take into account its own heating effects, unit is then operated at 100% duty cycle at 20°C with I_F = 100 mA and peak output wavelength is recorded. The voltage drop (V_D) across the driven output is then measured. (See 6.4).

4.6.11 Linearity.- With the device driven at 1 MHz, a spectrum analyzer with resolution of at least 1 KHz coupled to a silicon photodiode, shall be used to measure the second harmonic content.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging and packing.- Units shall be prepared for delivery as specified in the contract.

6. NOTES

6.1 Abbreviations, symbols, and definitions.- The abbreviations, symbols and definitions are as follows:

λ_p	peak emission wavelength
ΔF	bandwidth
I	radiant intensity
I_F	average forward current
I_p	input peak current
I_r	reverse current
P_{opt}	optical power output
t_r	rise time
t_f	fall time
V_D	voltage drop
V_r	breakdown voltage (reverse)

6.2 Radiant intensity (I).- Radiant intensity is defined as follows:

$$I = \frac{P_\lambda}{\Omega}$$

where: P_λ is power measured by detector

Ω is the solid angle of radiation and equal to

$$2\pi \int_0^{\theta} \sin\theta \, d\theta$$

6.3 Numerical aperture (N.A.).- Numerical aperture is defined as

$$N.A. = \sin \theta$$

6.4 Thermal impedance (Z_t).- Thermal impedance can be calculated taking slope (α) of curve λ_p vs temperature measured in 4.6.10 and the following:

$$Z_t = \frac{\Delta T}{P}$$

where: $P = I_f V_D$

and $$T = \frac{\Delta \lambda}{\alpha}$$

where: I_f = peak input current (100 mA)

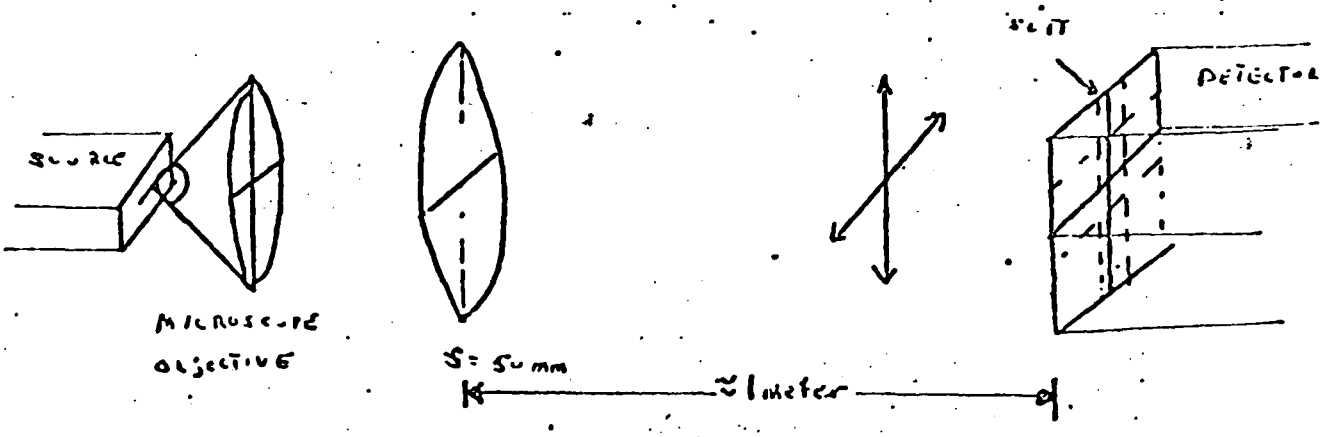
ΔT, $\Delta \lambda$ taken from graph

6.5 Method for calibration of silicon photodiode detector.- This information can be found pages 180 to 190 in "Laser Parameter Measurements Handbook."

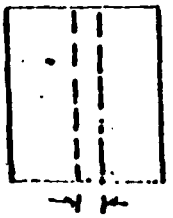
6.6 Fiber characteristics.- The optical fiber segments use in manufacturing the light emitting diode devices shall come from optical fiber lengths having the characteristics shown in Table VI.

Table VI.- Fiber characteristics

Characteristics	Min	Nom.	Max	Unit
attenuation (at λ_p)	...		50	db/km
core diameter		55	62.5	um
cladding diameter		125		um
protective jacket diameter		500		µm
numerical aperture (N.A.)			0.3	
tensile strength	50			Newtons
bending radius		5		mm

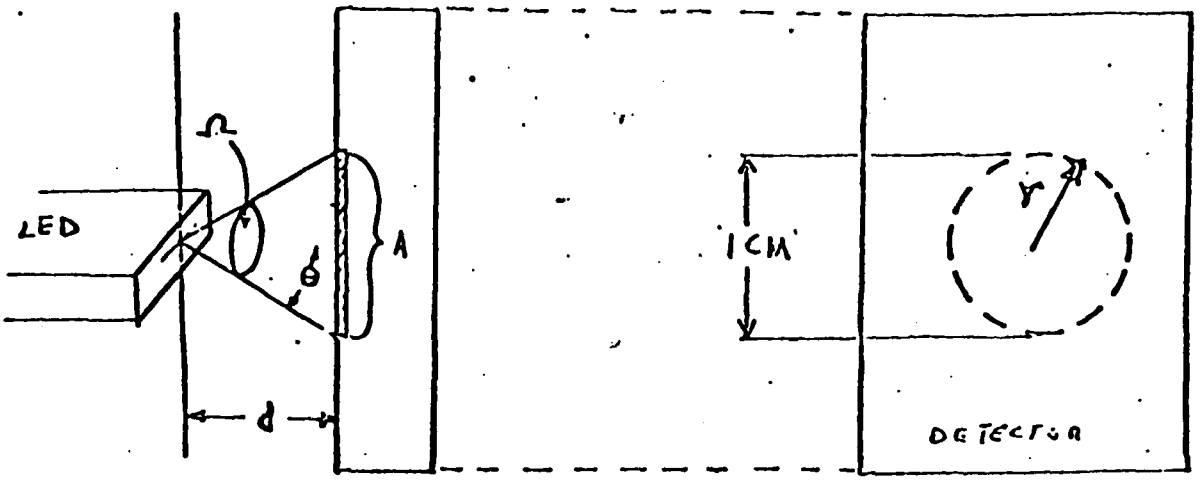


FRONT VIEW
OF DETECTOR



0.5mm = SLIT SIZE

Figure 2. [illegible]



d = distance from detector $\approx$ 1.58 cm

Ω = solid angle of radiation

A = circular area of detector exposed to radiation

θ = $\frac{1}{2}$ angle of cone ($\theta \approx 17°$)

r = radius of projection $\approx$ 0.5 cm

Figure 3 Radiant Intensity

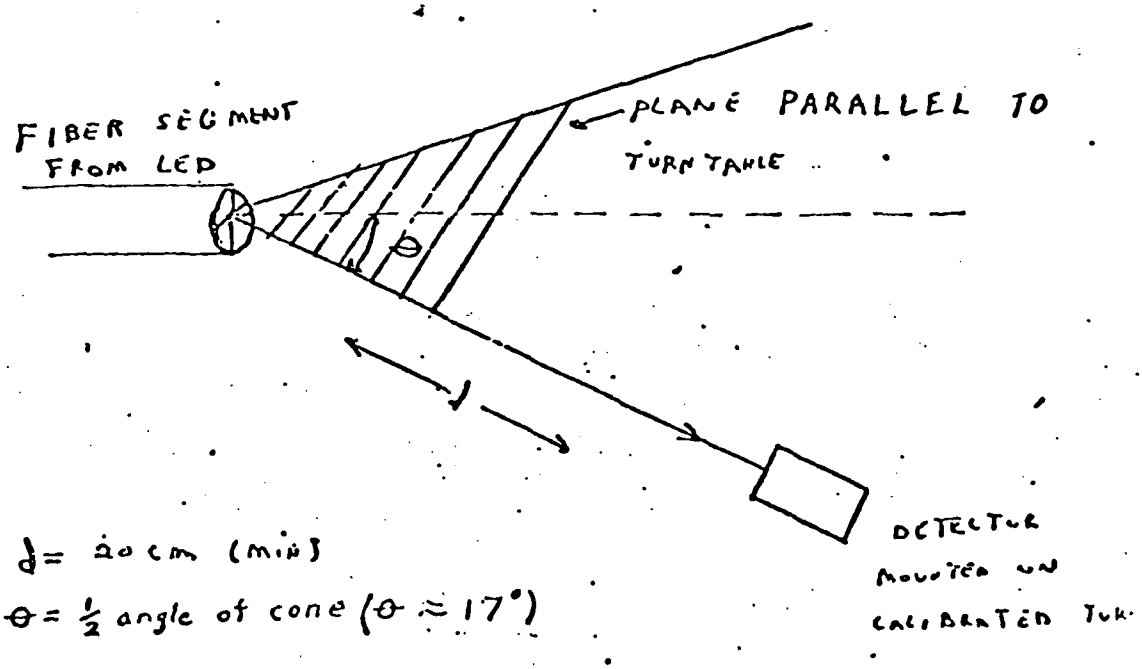


Figure 4. Numerical aperture of optical fiber output

ELECTRONICS COMMAND
TECHNICAL REQUIREMENTS

SCS-511
AMENDMENT-1
29 December 1975

LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

Page 9

Table V, Subgroup 2, under Details column for Resistance to solvents, add, "except solvents used shall be:

(a) Methyl alcohol, per O-M-232, Grade A.

(b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.

(c) Isopropyl alcohol, per TT-I-735, Grade A.

(d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

Page 10

4.6.1 add, "except solvents used shall be:

(a) Methyl alcohol per O-M-232, Grade A.

(b) Ethyl alcohol per O-E-00760, Type 1, Grade A.

(c) Isopropyl alcoholper TT-I-735, Grade A.

(d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

4.6.8 line 1, delete "photodiode" and substitute "photodiode"

Page 11

4.6.10, lines 4 and 5, delete "20°C" and substitute "25°C"

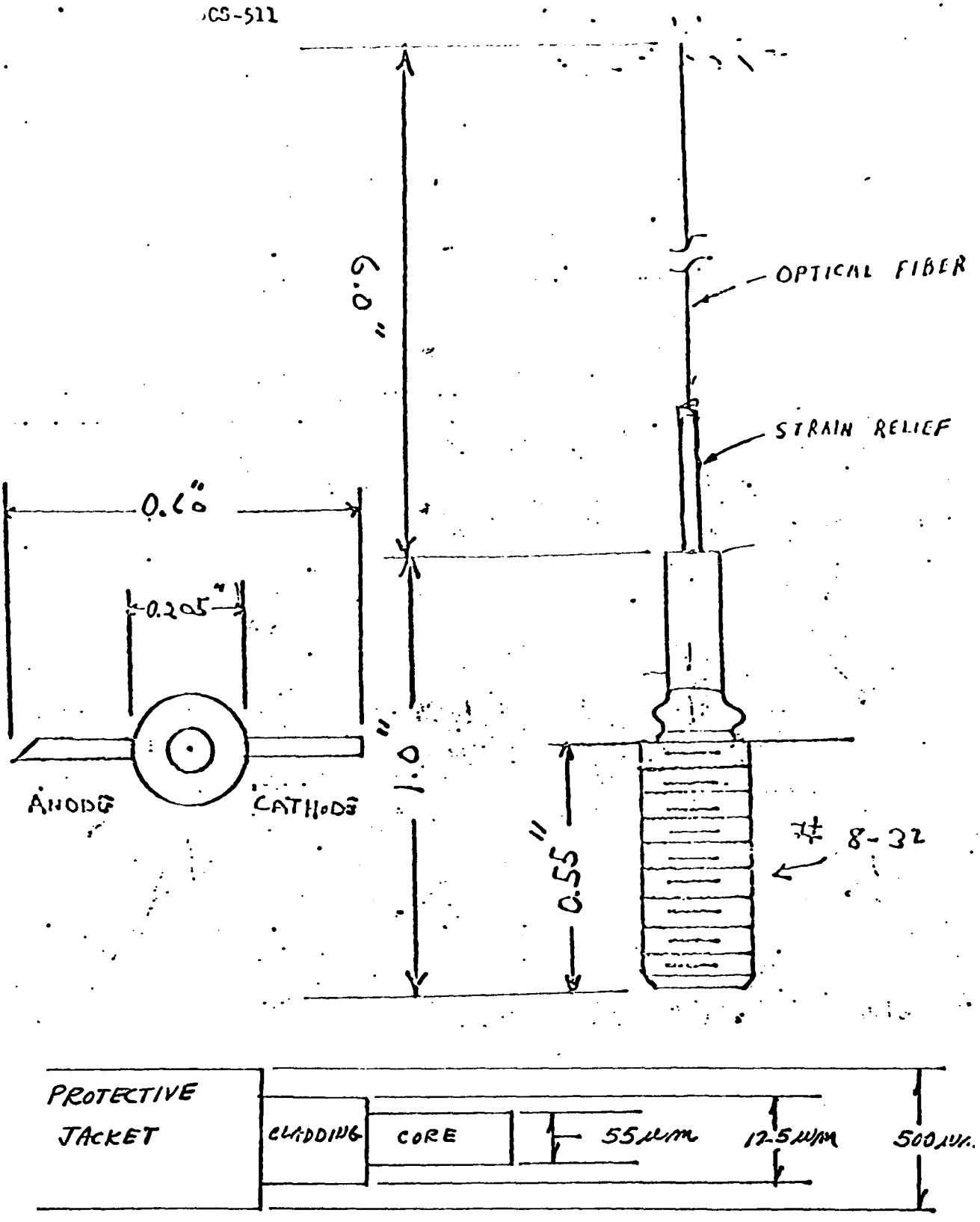


FIG. 1 PHYSICAL DIMENSIC

STANDARD FORM 30, MAY 1969
GENERAL SERVICES ADMINISTRATION
FPR PCR. NO. 1 (41 CFR) 1-16.101

MODIFICATION OF CONTRACT

PAGE 1 OF 8

1. MODIFICATION NO. P00001	2. EFFECTIVE DATE See Block 19 below	3. REQUISITION/PURCHASE REQUEST NO. [illegible]	4. PROJECT NO. (If applicable)

5. ISSUED BY: CODE W15QKT
USAECOM PROCUREMENT BRANCH, DIRECTORATE OF PROCUREMENT, USAECOM, FT MONMOUTH, NJ 07703; Buyer/Symbol: CPT L'HEUREUX/DRSEL-PP-C-S-2(LH) Phone: 201-532-1436

6. ADMINISTERED BY (If other than block 5): CODE S3101A
DCASMA, Springfield
240 Route 22
Springfield, NJ 07081

7. CONTRACTOR NAME AND ADDRESS (Street, city, county, state, and ZIP Code): CODE 40331 FACILITY CODE
LASER DIODE LABORATORIES, INC.
205 Forrest Street
Metuchen, NJ 08817

8.
☐ AMENDMENT OF SOLICITATION NO. _____
DATED _____ (See block 9)
☒ MODIFICATION OF CONTRACT NO. DAAB07-76-C-8135
DATED 76 SEP 30 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods: (a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)
N/A

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

CONTRACTOR'S COPY

(a) ☐ This Change Order is issued pursuant to: _____
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of: Subsection I.2 (Changes Article)
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF MODIFICATION

This Modification adds to the contract a third and fourth engineering sample, reduces the quantity of the Pilot Run from five-hundred (500) to two-hundred and fifty (250) units, and changes the scheduled delivery dates.

I

Section E, Supplies/Line Item Data, is changed as set forth in inclosed DD Form SDA 69E.

Section F, Description/Specifications, is amended as follows:

Subsection F.2 is changed as follows:

Add: Amendment 1 to SCS-511 dated 29 Dec 75.
Amendment 2 to SCS-511 dated 4 Aug 76.
Amendment 3 to SCS-511 dated 20 September 76.
Amendment 4 to SCS-511 dated 12 May 78.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 1 COPY to ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR		17. UNITED STATES OF AMERICA	
BY _____ (Signature of person authorized to sign)		BY _____ (Signature of Contracting Officer)	
15. NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED	18. NAME OF CONTRACTING OFFICER (Type or print): STEPHEN L. THACHER, Major, Signal Corps	19. DATE SIGNED

30 101-08

*U.S. GOVERNMENT PRINTING OFFICE: 1973-523-792

Subsection F.48, Subparagraph 4 is changed as follows:

Change - Commander, US Army Electronics Command, ATTN: DRSEL-CT-LD to Commander, US Army Electronics Research and Development Command, ATTN: DELNV-L-C and Commander, US Army Electronics Command, ATTN: DRSEL-PP-I-PI-1 to Commander, US Army Electronics Research and Development Command, ATTN: DELSD-D-PC.

Section H, Supplies Schedule Data, is changed as set forth in inclosed DD Form SDA 69H.

Section I, Inspection and Acceptance, is amended as follows:

Section I.14

Change - Commander, US Army Electronics Command, ATTN: DRSEL-CT-LD, Fort Monmouth, NJ 07703 to Commander, US Army Electronics Research and Development Command, ATTN: DELNV-L-C, Fort Monmouth, NJ 07703.

Change - Commander, US Army Electronics Command, ATTN: DRSEL-RD-ET-2, Fort Monmouth, NJ 07703 to Commander, US Army Electronics Research and Development Command, ATTN: DELNV-L-C, Fort Monmouth, NJ 07703.

Change - Commander, US Army Electronics Command, ATTN: DRSEL-PP-I-PI-1, Fort Monmouth, NJ 07703 to Commander, US Army Electronics Research and Development Command, ATTN: DELSD-D-PC, Fort Monmouth, NJ 07703.

Section J, Special Provisions, is amended as follows:

Add: Subsection J.10 as follows:

XX J.10 Government Property Material

a. Subject to the "Government Property" provision of this contract (see Section L), the Government will furnish to the Contractor all of the following property:

STOCK NUMBER	DESCRIPTION	UNIT ALLOWANCE	GROSS ALLOWANCE	APPLIES TO CONTRACT ITEM (SLIN)
N/A	Graded Index Fiber Type ITT GG-02-8	1 Reel (50 Meters)	1 ea	CLIN 0001

Note: Material to be consumed during performance of contract.

b. Delivery of Government furnished property will be made to the Contractor in the manner determined by the Contracting Officer. Government property, including all such property acquired by the Contractor, all non-expendable property, and any expendable items of property not expended in connection with this contract, shall be delivered by the Contractor to the Government, F.O.B. Contractor's plant, and then shipped by Government Bill of Lading in accordance with instructions received from the Contracting Officer, unless the Contracting Officer directs or authorizes the Contractor to dispose of such property otherwise. Disposal instructions regarding scrap or wastage, if any, will be given to the Contractor by the Contracting Officer at a later date.

c. Within thirty (30) days after Government furnished property is determined by the Contractor to be lost, damaged, destroyed, no longer usable, or no longer needed for the performance of the Contract, the Contractor shall notify the Contracting Officer thereof.

d. The Contractor agrees that the Government Furnished Material listed above is sufficient as to quantity to perform the contract.

Section K, Contract Administration Data, is amended as follows:

Delete: Subsection K.2(a) in its entirety and substitute therefore:

The Purchasing Office Representative is:

NAME: CPT Roy W. L'Heureux

ORGANIZATIONAL CODE: DRSEL-PC-C-CS-2(LHE)

TELEPHONE AREA CODE AND NO.: (201)-532-1436

AUTOVON NO.: 992-1436

Section M is amended as follows:

DD 1423 Form, Exhibit B, Item B002 and Exhibit D, D001:

Change - Code W15P7N to W15P8S.

II

PCO responsibility for this contract has changed as follows:

FROM	TO
Mr. Gordon McMain DRSEL-PC-C-CS-1	Stephen L. Thacher Major, Signal Corps DRSEL-PC-C-CS-2(THA) Phone: (201)-532-3506

III

Inclusion of the above changes shall be at no additional cost to the Government. All other terms and conditions of this contract remain in effect.

REF 69D 69E

PART II SECTION I OF THE SCHEDULE — SUPPLIES LINE ITEM DATA | 1. PROCUREMENT ID NO. (PIIN) DAAH07-76-C-8135 | 2. SPIIN P00001 | 3. PAGE 4 OF 8

3

4. ITEM NO. 0001AA | 5. QUANTITY* | 6. PURCH UNIT LT | 7. UNIT PRICE $ N | 8. TOTAL ITEM AMOUNT* $ NSP

9. SCTY CLAS U | 10. ACRN AA | 11. NSN N | 12. FSCM AND PART NUMBER | 13. CIRR

14. SITE CODES A.POA U B.ACP U C.POD D | 15. NOUN ENGR SAMPLES | 16. QUANTITY VARIANCE A. OVER % B. UNDER % | 17. ITEM/PROJ MGR | 18. SVC/AGENCY USE C96H0056C9CA/00

19. DESCRIPTIVE DATA Engineering Samples in accordance with Para. 1.2.12 and 3.1.7 of ECIPPR No. 15, SCS-511 and Subsection F.47. The samples shall be comprised of two submissions: 10 samples for the first submission and 16 samples for the second submission, for a total of 26 samples. Commercial Packaging, Packing and Marking in accordance with Subsection G.4.

11

4. ITEM NO. 0001AB | 5. QUANTITY* 4 | 6. PURCH UNIT LT | 7. UNIT PRICE $ N | 8. TOTAL ITEM AMOUNT* $ NSP

9. SCTY CLAS U | 10. ACRN AA | 11. NSN N | 12. FSCM AND PART NUMBER | 13. CIRR

14. SITE CODES A.POA D B.ACP D C.POD D | 15. NOUN ENGR SAMPLES | 16. QUANTITY VARIANCE A. OVER % B. UNDER % | 17. ITEM/PROJ MGR | 18. SVC/AGENCY USE C96N0056C9CA/01

21

19. DESCRIPTIVE DATA Engineering Samples in accordance with Para. 1.2.12 and 3.1.7 of ECIPPR No. 15, SCS-511 and Subsection F.47. The samples shall be comprised of four submissions: 10 samples for the first and third submissions and 16 samples for the second and fourth submissions, for a total of 52 samples. Commercial Packaging, Packing and Marking in accordance with Subsection G.4.

4. ITEM NO. 0001AC | 5. QUANTITY* 1 | 6. PURCH UNIT LT | 7. UNIT PRICE $ N | 8. TOTAL ITEM AMOUNT* $ NSP

9. SCTY CLAS U | 10. ACRN AA | 11. NSN N | 12. FSCM AND PART NUMBER | 13. CIRR

31

14. SITE CODES A.POA S B.ACP S C.POD S | 15. NOUN PILOT RUN | 16. QUANTITY VARIANCE A.OVER % B. UNDER % | 17. ITEM/PROJ MGR | 18. SVC/AGENCY USE C96N0056C9CA/00

19. DESCRIPTIVE DATA Pilot run comprised of a quantity of five-huncred (500) acceptable units in accordance with Para. 3.1.10 of ECIPPR No. 15, Subsections F.49 and SCS-511. Commercial Packaging, Packing and Marking in accordance wtih Subsection G.4.

4. ITEM NO. 0001AC | 5. QUANTITY* 1 | 6. PURCH UNIT LT | 7. UNIT PRICE $ N | 8. TOTAL ITEM AMOUNT* $ NSP

41

9. SCTY CLAS U | 10. ACRN AA | 11. NSN N | 12. FSCM AND PART NUMBER | 13. CIRR

14. SITE CODES A.POA S B.ACP S C.POD S | 15. NOUN PILOT RUN | 16. QUANTITY VARIANCE A. OVER % B. UNDER % | 17. ITEM/PROJ MGR | 18. SVC/AGENCY USE C96N0056C9CA/01

19. DESCRIPTIVE DATA Pilot run comprised of a quantity of two-hundred and fifty (250) acceptance units in accordance with Para. 3.1.10 of ECIPPR No. 15, Subsections F.49 and SCS-511. Commercial Packaging, Packing and Marking in accordance with Subsection G.4.

51

*REPRESENTS NET AMOUNT OF INCREASE/DECREASE WHEN MODIFYING EXISTING ITEM NO.

N = NOT APPLICABLE
U = UNDEFINITIZED
NSP = NOT SEPARATELY PRICED
E = ESTIMATED
– (IN QTY AND $) = DECREASE
+ OR – (IN ITEM NO.) = ADDITION OR DELETION
CIRR: CONTROLLED ITEM RPT RQMT

SITE CODES: S = SOURCE, D = DESTINATION, O = INTERMEDIATE

DD FORM PROPOSED (SDA 69E) APR 75

CONTINUATION SHEET	PROCUREMENT INSTRUMENT ID NO. (PIIN) DAAB07-78-C-3139	SOLICITATION NO. P00001	PAGE 5 OF 8

PART II SECTION H
SUPPLIES SCHEDULE DATA

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0001AA +	AA	W15P8S				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0001

17. DESCRIPTIVE DATA

Third Engineering Samples (10 each)
SHIP TO: Commander
US Army Electronics Research & Development Command
ATTN: DELNV-L-C
Fort Monmouth, NJ 07703

DELIVERY: 1 August 78

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0001AA +	AA	W15P8S				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0001

17. DESCRIPTIVE DATA

Fourth Engineering Samples (16 each)
SHIP TO: Same as above.

DELIVERY: 1 September 1978

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0001AB -	AA	W15P8S				1 Lot

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0001

17. DESCRIPTIVE DATA

Confirmatory Samples (25 each)
SHIP TO: Commander
US Army Electronics Command
ATTN: DRSEL-RD-ET-2
Fort Monmouth, NJ 07703

DELIVERY: 480 Days after effective date of contract.

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0001AB +	AA	W15P8S				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0001

17. DESCRIPTIVE DATA

Confirmatory Samples (25 each)
SHIP TO: Commander
US Army Electronics Command
ATTN: DRSEL-CT-LD
Fort Monmouth, NJ 07703

DELIVERY: 840 Days after effective date of contract.

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0001AB +	AA	W15P7N				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0001

17. DESCRIPTIVE DATA

Confirmatory Samples (25 each)
SHIP TO: Commander
US Army Electronics Research & Development Command
ATTN: DELNV-L-C
Fort Monmouth, NJ 07703

DELIVERY: 1 January 1978

*REPRESENTS A NET INCREASE/DECREASE WHEN NO + OR – APPEARS AFTER THE ITEM NO.

E = ESTIMATED

– (IN QTY) = DECREASE

+ OR – (IN ITEM NO.) = ADDITION OR DELETION

DD FORM PROPOSED (SDA 69H) APR 78

CONTINUATION SHEET | PROCUREMENT ID NO. (PIIN) DAAB07-[illegible]-8135 | SPIIN P00001 | PAGE 6 OF 8

PART II SECTION H
SUPPLIES SCHEDULE DATA

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0001AB	AA	W15P7N				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0001

17. DESCRIPTIVE DATA

Confirmatory Samples (25 each)
SHIP TO: Commander
US Army Electronics Research & Development Command
ATTN: DELNV-L-C
Fort Monmouth, NJ 07703

DELIVERY: 2 January 1980

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0001AC	AA	W15P8S				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0001

17. DESCRIPTIVE DATA

Pilot Run
SHIP TO: Commander
US Army Electronics Command
ATTN: DRSEL-CT-LD
Fort Monmouth, NJ 07703

DELIVERY: 690 Days after effective date of contract.

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0001AC	AA	W15P8S				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0001

17. DESCRIPTIVE DATA

Pilot Run
SHIP TO: Commander
US Army Electronics Research & Development Command
ATTN: DELNV-L-C
Fort Monmouth, NJ 07703

DELIVERY: 1 August 1979

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
B001	AA	W15P8S				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0003

17. DESCRIPTIVE DATA

Report on Third Engineering Samples
SHIP TO: (2 copies) Commander
US Army Electronics Research & Development Command
ATTN: DELNV-L-C
Fort Monmouth, NJ 07703
and 1 copy to W15P7R

DELIVERY: 1 August 1978

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
B001	AA	W15P8S				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0003

17. DESCRIPTIVE DATA

Report on Fourth Engineering Samples
SHIP TO: 2 copies to: Address above
1 copy to W15P7R

DELIVERY: 1 September 1978

*REPRESENTS A NET INCREASE/DECREASE WHEN NO + OR – APPEARS AFTER THE ITEM NO.

E = ESTIMATED

– (IN QTY) = DECREASE

+ OR – (IN ITEM NO.) = ADDITION OR DELETION

DD FORM PROPOSED (SDA 69H) APR 75

6911 6911

CONTINUATION SHEET | DAAB07-[illegible] | P00001 | PAGE 7 OF 8

PART II SECTION H
SUPPLIES SCHEDULE DATA

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
C003	AA	W15P7R				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0004

17. DESCRIPTIVE DATA: Final Report

SHIP TO: W15P7R
Delivery: Draft due 890 days after effective date of contract.

For additional delivery data, see Exhibit C, Sequence No. C003.

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
C003	AA	W15P7R				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0004

17. DESCRIPTIVE DATA: Final Report

SHIP TO: W15P7R
DELIVERY: Draft due 1 March 1980.

For additional delivery data, see Exhibit C, Sequence No. C003.

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
C004	AA	W15P7R				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0004

17. DESCRIPTIVE DATA: General Report

SHIP TO: 2 copies - W15P7R
DELIVERY: 840 days after effective date of contract.

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
C004	AA	W15P7R				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0004

17. DESCRIPTIVE DATA: General Report

SHIP TO: 2 copies - W15P7R.
DELIVERY: 2 January 1980

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
E001	AA	W15P7R				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0007

17. DESCRIPTIVE DATA: Production Capability Demonstration Plan

SHIP TO: W15P7R
DELIVERY: 690 Days after effective date of contract.

*REPRESENTS A NET INCREASE/DECREASE WHEN NO + OR – APPEARS AFTER THE ITEM NO.

E = ESTIMATED

– (IN QTY) = DECREASE

+ OR – (IN ITEM NO.) = ADDITION OR DELETION

DD FORM PROPOSED (SDA 69H) APR 78

6911 6911

CONTINUATION SHEET	1. PROC INSTRUMENT ID NO. (PIIN) DAAK [illegible]-8135	2. SPIIN P00004	3. PAGE 3 OF 8

PART II SECTION H
SUPPLIES SCHEDULE DATA

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
E001 +	AA	W15P7R				1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0007

17. DESCRIPTIVE DATA Production Capability Demonstration Plan

SHIP TO: W15P7R
DELIVERY: 1 August 1979

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0008 +	AA					1 LOT

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					

17. DESCRIPTIVE DATA Additional Life Testing

DELIVERY: To be completed by 840 days after effective date of contract.

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*
0008 +	AA					

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT
U					0008

17. DESCRIPTIVE DATA Additional Life Testing

DELIVERY: 2 January 1980.

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT

17. DESCRIPTIVE DATA

4. ITEM NO.	5. ACRN	6. SHIP TO	7. MARK FOR	8. DEL SCHED DATE	9. ENDING DATE (WHEN APPL)	10. DEL SCHEDULE QTY*

11. SCTY CLAS	12. CON ITEM SERIAL NO.	13. ENDING SERIAL NO. (WHEN APPL)	14. TSP PRI	15. MILSTRIP DOC NO. AND SUFFIX	16. CLIN IDENT EXHIBIT

17. DESCRIPTIVE DATA

*REPRESENTS A NET INCREASE/DECREASE WHEN NO + OR – APPEARS AFTER THE ITEM NO.

E = ESTIMATED

– (IN QTY) = DECREASE

+ OR – (IN ITEM NO.) = ADDITION OR DELETION

LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

Page 9

Table V, Subgroup 2, under Details column for Resistance to solvents, add, "except solvents used shall be:

(a) Methyl alcohol, per O-M-232, Grade A.

(b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.

(c) Isopropyl alcohol, per TT-I-735, Grade A.

(d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

Page 10

4.6.1 add, "except solvents used shall be:

(a) Methyl alcohol per O-M-232, Grade A.

(b) Ethyl alcohol per O-E-00760, Type 1, Grade A.

(c) Isopropyl alcohol per TT-I-735, Grade A.

(d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

4.6.8 line 1, delete "phtodiode" and substitute "photodiode"

Page 11

4.6.10, lines 4 and 5, delete "20°C" and substitute "25°C"

ELECTRONICS COMMAND
TECHNICAL REQUIREMENTS

SCS-511
AMENDMENT-2
4 August 1976
SUPERSEDING
AMENDMENT-1
29 December 1975

LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

This amendment forms a part of Electronics Command Technical Requirements SCS-511, 14 August 1975

Page 7

* Table III, Subgroup 3, under Min column for Spectral width, delete "40".

Page 9

Table V, Subgroup 2, under Details column for Resistance to solvents, add, "except solvents used shall be:

(a) Methyl alcohol, per O-M-232, Grade A.

(b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.

(c) Isopropyl alcohol, per TT-I-735, Grade A.

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Page 10

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(c) Isopropyl alcohol, per TT-I-735, Grade A.

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4.6.8 line 1, delete "phtodiode" and substitute "photodiode"

Page 11

4.6.10, lines 4 and 5, delete "20°C" and substitute "25°C"

* 4.6.4 line 2, delete "one angstrom" and substitute "10 angstroms".

* 4.6.5 line 3, delete "1 angstrom" and substitute "10 angstroms".

* 4.6.7 line 1, delete "150" and substitute "100".

4.6.8 line 1, delete "phtodiode" and substitute "photodiode".

Page 11

4.6.10 lines 4 and 5, delete "20°C" and substitute "25°C".

* 6.1 insert "V_{br} reverse breakdown voltage" after V_D.

* 6.1 for V_r, delete "breakdown voltage (reverse)" and substitute "reverse voltage".

Page 13

* Table VI, for core diameter, delete "125" under Min column and substitute "125" under Max column.

Page 14

Fig. 1, delete ".205"" and substitute ".27" max."

NOTE: The margins of this amendment are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous amendment were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous amendment.

LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

This amendment forms a part of Electronics Command Technical Requirements SCS-511, 14 August 1975

Page 7

* Table III, Subgroup 2, for Reverse breakdown voltage, delete "3.0" under Max column and substitute "3.0" under Min column.

Table III, Subgroup 3, under Min column for Spectral width, delete "40".

Page 8

* Table IV, Subgroup 5, under Conditions column, delete "85°C" and substitute "25°C".

Page 9

Table V, Subgroup 2, under Details column for Resistance to solvents, add, "except solvents used shall be:

(a) Methyl alcohol, per O-M-232, Grade A.

(b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.

(c) Isopropyl alcohol, per TT-I-735, Grade A.

(d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

Page 10

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(a) Methyl alcohol, per O-M-232, Grade A.

(b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.

(c) Isopropyl alcohol, per TT-I-735, Grade A.

(d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

* Fig. 1, delete ".205"" and substitute ".27" max."

NOTE: The margins of this amendment are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous amendment were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous amendment.

LIGHT EMITTING DIODE FOR USE IN FIBER
OPTIC COMMUNICATIONS

This amendment forms a part of Electronics Research and Development Technical Requirements SCS-511, 14 August 1975.

Page 7

TABLE III, Subgroup 2, Output optical power delete "0.5 mw" and substitute " .100 mw".

Page 13

Under TABLE VI - Fiber Characteristics add heading titled "Nom" and make the following changes:

Core diameter - delete "125" under Max heading
add "55" under Nom heading
add "62.5" under Max heading

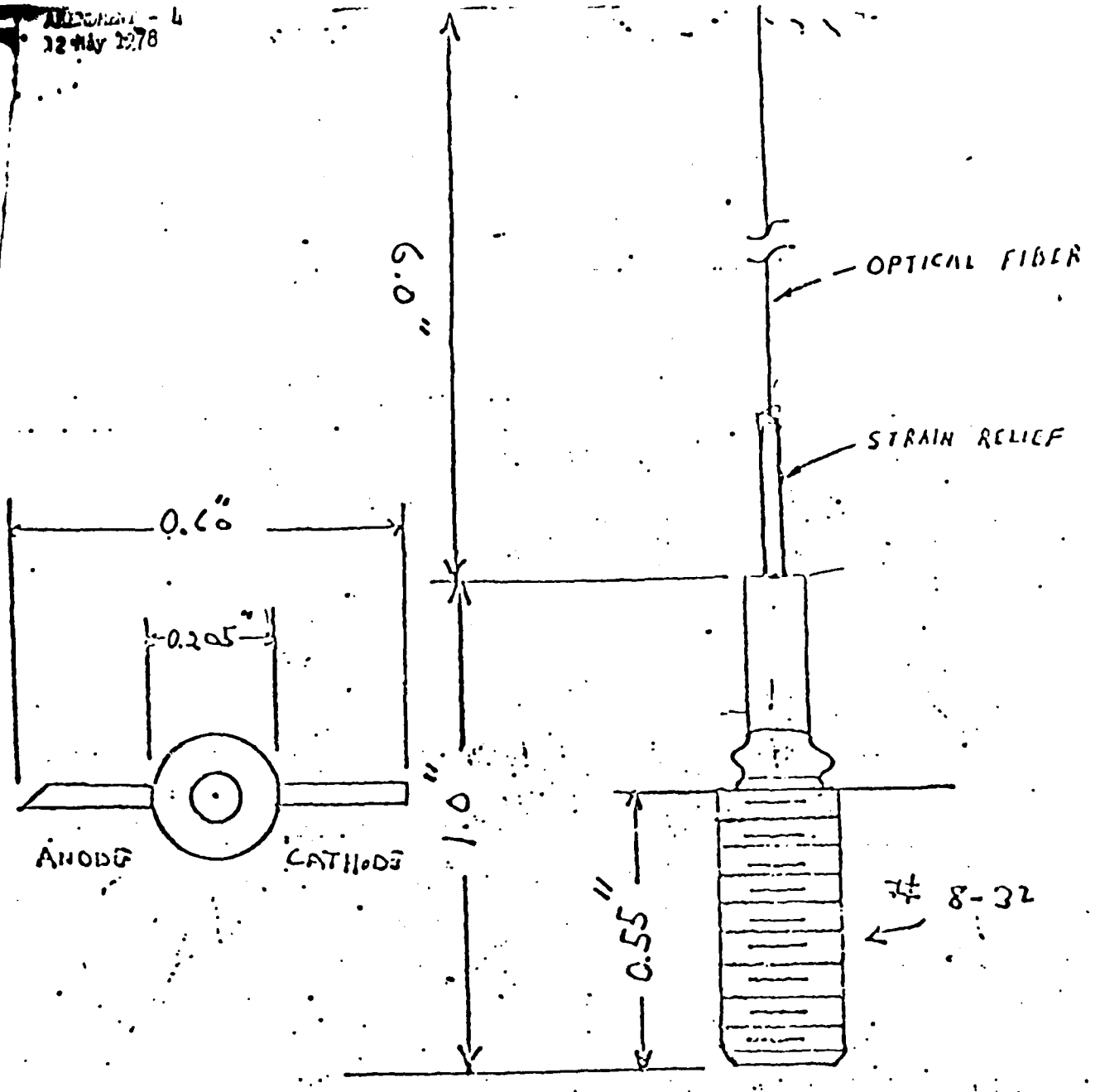
Cladding diameter - delete "150" under Min heading
add "125" under Nom heading

Protective Jacket diameter - delete "1" under Min heading
delete "mm" under Unit heading
add "500" under Nom heading
add "um" under Unit heading

Bending Radius - delete "1.5" under Min heading
add ""5" under Nom heading

Page 14

Replace FIG 1 with attached FIG 1 (AMENDMENT - 4).



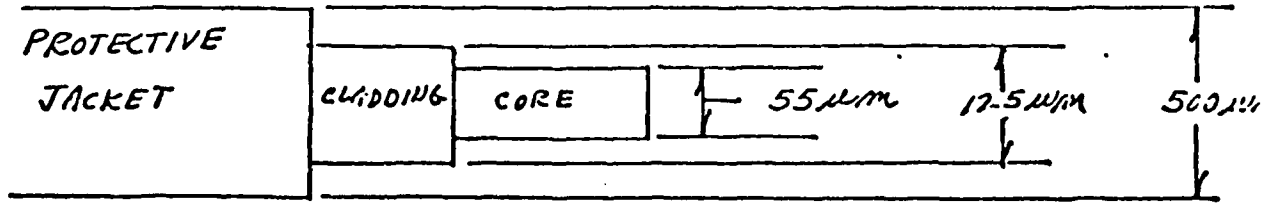


FIG. 1 PHYSICAL DIMENSIO

CORADCOM
TECHNICAL REQUIREMENTS

SCS-511
AMENDMENT 5
23 Sep 1980
SUPERSEDING AMENDMENT 4
12 May 1978

LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS

This amendment forms a part of Electronics Command Technical Requirements SCS-511, 14 August 1975.

Page 2

3.2.4 line 2, delete "35 db" and substitute "26db".

3.3.1 line 2, delete "hot solder dip" and substitute "gold plated".

Page 3

3.4 line (d), delete.

Page 5

4.5.2.2 line 5, delete "1%" and substitute "5%".

Page 7

TABLE III, Subgroup 2, Peak emission wavelength, delete "830" under Max column and substitute "890".

TABLE III, Subgroup 2, Output Optical Power, delete "0.5" under Min column and substitute "0.075".

TABLE III, Subgroup 3, Spectral width, delete "40" under Min column, delete "45" under Max column and substitute "50".

TABLE III, Subgroup 3, Bandwidth, delete "44" under Max Column.

TABLE III, Subgroup 3, Rise and fall time, delete "10" under Min Column.

Page 8

TABLE IV, Subgroup 5, under Conditions Column, delete "85°C" and substitute "25°C".

Page 9

TABLE V, Subgroup 2, under Details column for Resistance to solvents, add "except solvents used shall be:

(a) Methyl alcohol, per O-M-232, Grade A.

(b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.

(c) Isopropyl alcohol, per TT-I-735, Grade A.

(d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

Page 10

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(a) Methyl alcohol, per O-M-232, Grade A.

(b) Ethyl alcohol, per O-E-00760, Type 1, Grade A.

(c) Isopropyl alcohol, per TT-I-735, Grade A.

(d) Three (3) parts by volume of isopropyl alcohol, as specified in (c) above and one (1) part by volume of distilled water."

4.6.4 line 2, delete "one angstrom" and substitute "10 angstroms".

4.6.5 line 3, delete "1 angstrom" and substitute "10 angstroms".

4.6.7 line 1, delete "150" and substitute "100".

4.6.8 line 1, delete "phtodiode" and substitute "photodiode".

Page 11

4.6.10 lines 4 and 6, delete "20°C" and substitute "25°C".

6.1 insert "V_{br} reverse breakdown voltage" after V_D.

6.1 for V_r, delete "breakdown voltage (reverse)" and substitute "reverse voltage".

Page 13

Under TABLE VI - Fiber Characteristics add heading titled "Nom" and make the following changes:

Core Diameter - delete "125" under Max heading
add "55" under Nom heading
add "62.5" under Max heading

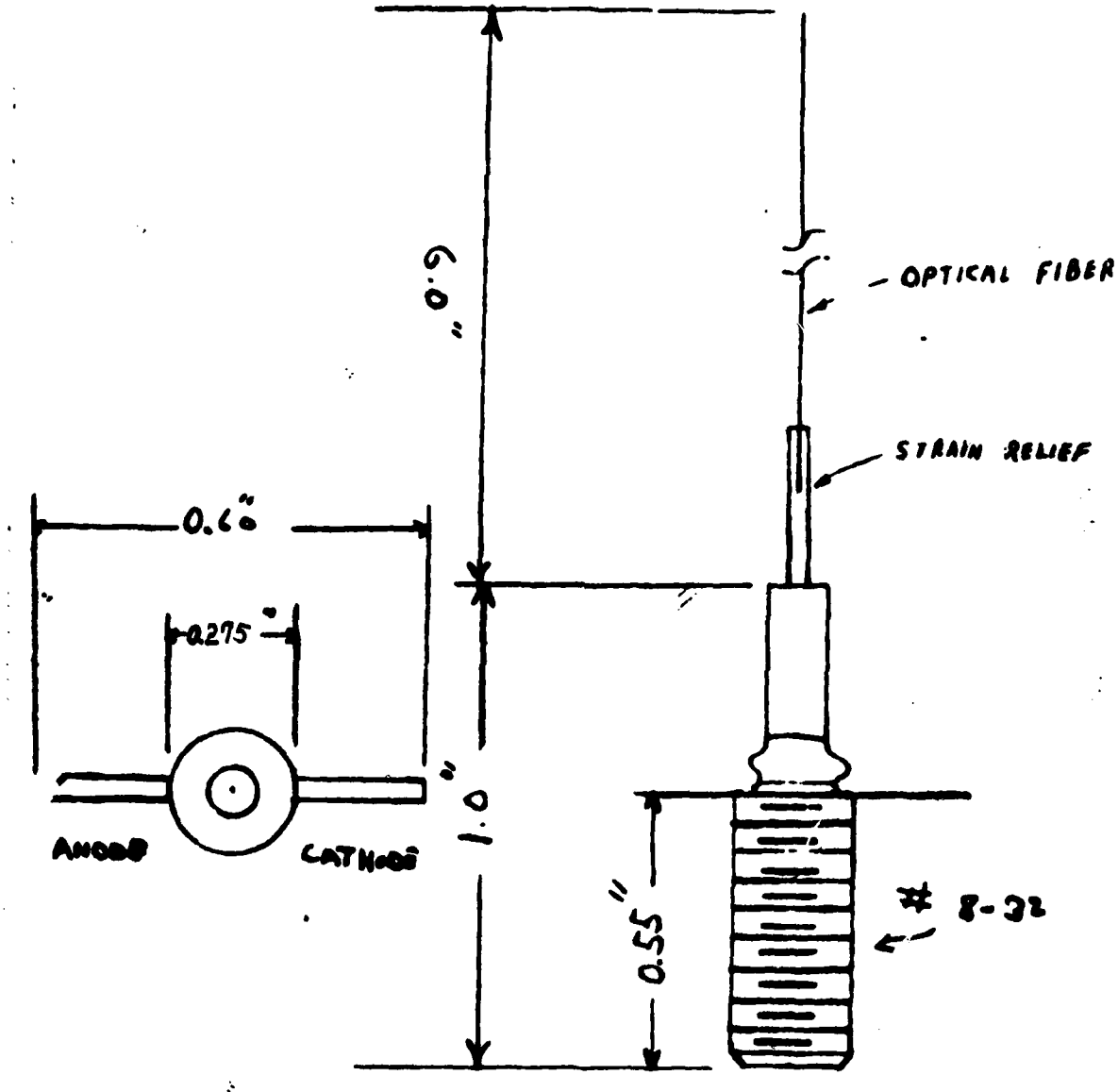
Cladding diameter - delete "150" under Min heading
add "125" under Nom heading

Protective Jacket diameter - delete "I" under Min heading
delete "mm" under Unit heading
add "500" under Nom heading
add "um" under Unit heading

Bending Radius - delete "1.5" under Min heading
add "5" under Nom heading

Page 14

Replace FIG 1 with attached FIG 1 (AMENDMENT 5).



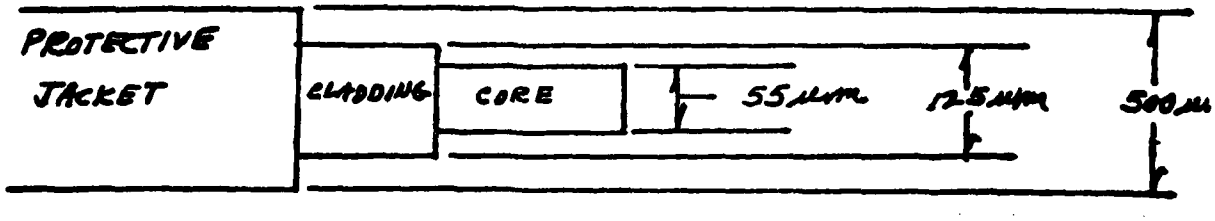
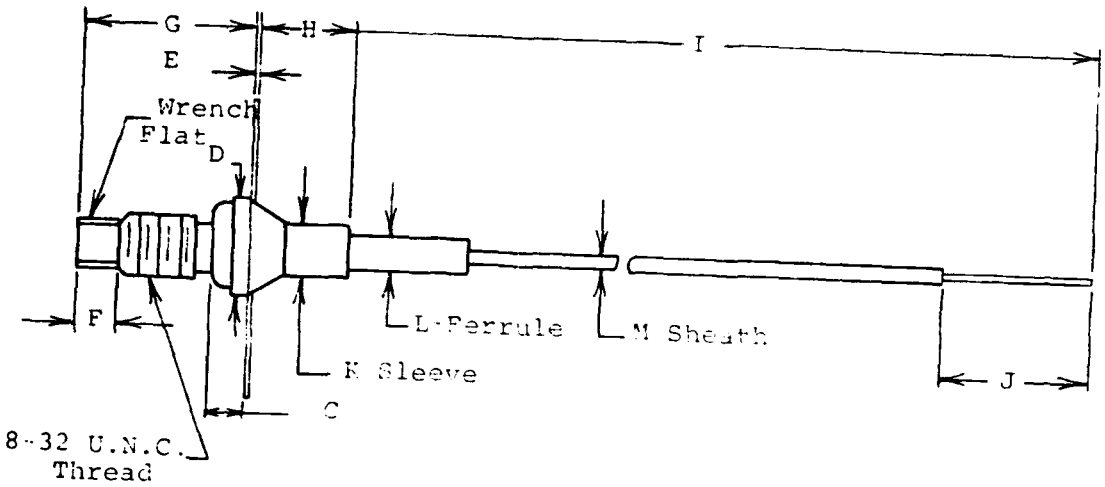
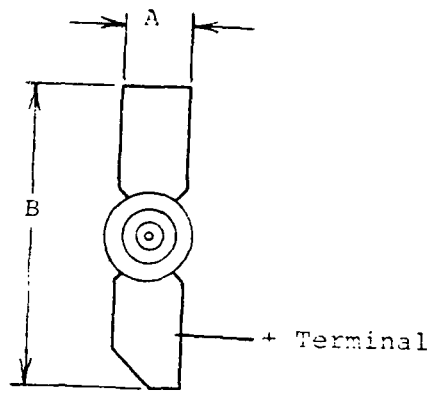
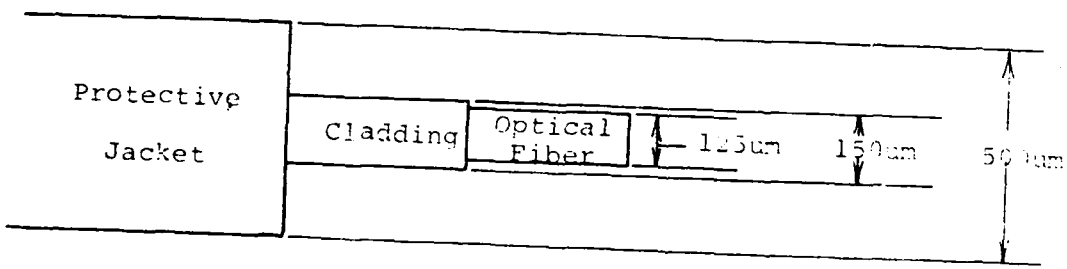


FIG. 1 PHYSICAL DIMENSIONS







SYMBOL	INCHES TYP.
A	.225
B	.875
C	.060
D	.275
E	.005
F	.115
G	.500
H	.330
I	6.00
J	1.00
K	.155
L	.098
M	.031

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF 9

1. AMENDMENT/MODIFICATION NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
DAAB07-76-C-8135, P00002	See Blk 19	N/A	

5. ISSUED BY	CODE	6. ADMINISTERED BY (If other than block 5)	CODE
USACORADCOM, Procurement Directorate Proc Div D, Ft. Monmouth, N.J. 07703 Mr. John C. Hunter/DRDCO-PC-D(HUN) (201) 532-1716	W15BAY	DCASMA, Springfield 240 Route 22 Springfield, New Jersey 07081	S3101A

7. CONTRACTOR NAME AND ADDRESS (Street, city, county, state, and ZIP Code)
CODE 4D331 FACILITY CODE

Laser Diode Laboratories, Inc.
1130 Somerset Street
New Brunswick, New Jersey 08901

8.
☐ AMENDMENT OF SOLICITATION NO. _____
DATED _____ (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. DAAB07-76-C-8135
DATED 76 Sep 30 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

N/A

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to _____

The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of Changes Provision, Subsection L.2 of the contract.

It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

PROJECT: MANUFACTURING METHODS AND TECHNOLOGY PROGRAM OF LIGHT EMITTING DIODE FOR USE IN FIBER OPTIC COMMUNICATIONS.

I

PART II, THE SCHEDULE, SECTION E is amended as follows:

Add SLIN 0001AD to SUPPLIES/SERVICES

"0001AD Twenty-five (25) each Light Emitting Diode
LDL Part No. IRE 161
No Cost"

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 1 copy COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR		17. UNITED STATES OF AMERICA	
BY _____ (Signature of person authorized to sign)		BY _____ (Signature of Contracting Officer)	
15. NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED	18. NAME OF CONTRACTING OFFICER (Type or print) JOSEPH E. FEENEY	19. DATE SIGNED

30-105-38

*U. S. GOVERNMENT PRINTING OFFICE: 1977-247-046

II

PART II, THE SCHEDULE, SECTION F, Description/Specifications, is amended as follows:

1. Subsection F.2, Specifications/Drawings Listing - ADD the following Amendment to SCS511:

"Amendment 5 to SCS511 dated 23 September 1980".

2. Subsection F.48, Subparagraph 6 - Delete this paragraph in its entirety and substitute the following:

"6. Additional Confirmatory Sample Test Requirements:

Twenty-five (25) Confirmatory Samples will be subjected to a 2000 Hour Life Test. Upon completion the samples will be retested in accordance with Table II. The Life Test and Table II (Retest) data will be incorporated into the Final Report. The Life Test samples shall be shipped to the Government upon completion of tests."

3. Add the following subparagraph to SECTION F:

"F.50 FINAL REPORT - SUPPLEMENTAL INSTRUCTIONS

The Final Report shall be prepared in accordance with the requirements as specified by CDRL C003. In addition, the report shall contain an Executive Summary, Pilot Line Rate Data, and Life Test Data."

III

PART II, THE SCHEDULE, SECTION H, Deliveries or Performance:

DELETE the contents of this Section in its entirety and SUBSTITUTE the following:

CLIN/SLIN	ITEM	DELIVERY DATE
0001AA	Engineering Samples Total 52 ea (Lot 1,2,3,4)	Received & Accepted Oct 1978
0001AB	Confirmatory Samples 25 each (Lot 1)	21 Nov 1980
	25 each (Lot 2)(Life Test Units)	Not Later Than 27 Feb 1981

REVISED DELIVERY OR PERFORMANCE SCHEDULE (Cont)

CLIN/SLIN	ITEM	DELIVERY DATE
0001AC	Pilot Run Samples 250 each	16 Jan 1981
0001AD	Light Emitting Diode 25 each LDL Part N-IRE1C1	Not Later Than 27 Feb 1981
0002/A001	PERT	Received & Accepted
0003/B001	Engineering Sample Test Report (For Lots 1,2,3,4)	Received & Accepted
0003/B002	Confirmatory Sample Test Report (For Lots 1 & 2 except Life Test)	Received & Accepted
0004/C001	Monthly Technical Reports Reports for Oct 1976 thru Sep 1980	Received & Reviewed
	Oct 1980 Report	Not Later Than 10 Nov 1980
	Nov 1980 Report	Not Later Than 10 Dec 1980
	Dec 1980 Report	Not Later Than 10 Jan 1981
0004/C002	Quarterly Reports Reports for Dec 1976 thru Aug 1980	Received & Reviewed
	Oct 1980 Report	Not Later Than 10 Nov 1980
0004/C003	Final Report Draft Final	 14 Nov 1980 27 Feb 1981
0004/C004	General Report - DELETED (Incorporated as "Executive Summary in Final Report)	--
0004/C005	Pilot Line Rate Report - DELETED (Incorporated in the Final Report)	--

REVISED DELIVERY OR PERFORMANCE SCHEDULE (Cont)

CLIN/SLIN	ITEM	DELIVERY DATE
0005/D001	Test Plan (Confirmatory Samples)	Received & Accepted
0006	Production Capability Demonstration	11 Feb 1981
	Draft Invitation Letter	12 Dec 1980
	Industry Invitation Letters (Mailed By)	16 Jan 1981
0007/E001	Production Capability Demonstration Plan	
	Draft	12 Dec 1980
	Final	16 Jan 1981
0008AA	Life Tests	Completion Not Later Than 20 Feb 1981"

IV

PART II, THE SCHEDULE, SECTION I - Inspection and Acceptance -

DELETE the contents of this Section in its entirety and SUBSTITUTE the following:

"I.14 INSPECTION AND ACCEPTANCE

CLIN/SLIN	ITEM	FINAL INSPECTION/ACCEPTANCE PERFORMED BY: *
0001AA	Engineering Samples	Received & Accepted
0001AB	Confirmatory Samples	
	Lot 1	DELNV-L
	Lot 2 (After Life Test)	DELNV-L
0001AC	Pilot Run Samples	
	250 each	DELNV-L
0001AD	Light Emitting Diode	
	25 each	DRDCO-COM-RM-1
0002/A001	PERT	Received & Accepted

INSPECTION AND ACCEPTANCE (Cont)

CLIN/SLIN	ITEM	FINAL INSPECTION/ACCEPTANCE PERFORMED BY: *
0003/B001	Engineering Sample Test Report	Received & Accepted
0003/B002	Confirmatory Sample Test Report	Received & Accepted
0004/C001	Monthly Technical Reports Oct/Nov/Dec 1980 Reports	 DELNV-L
0004/C002	Quarterly Reports Oct 1980 Report	 DELNV-L
0004/C003	Final Report Draft Final	 DELNV-L DELNV-L
0005/D001	Test Plan (Confirmatory Sample)	Received & Accepted
0006	Production Capability Demonstration Draft Invitation Letter	DELNV-L DRDCO-PC-D
0007/E001	Production Capability Demonstration Plan Draft Final	 DELNV-L DELNV-L
0008AA	Life Tests	DELNV-L

*Responsibility codes used are not to be construed as full address identifiers. Full addressees and "SHIP TO" data cited below.

Verification of the capability of the contractor to fabricate the devices at the specified rate for the pilot run will be performed at the factory of the contractor during performance of the pilot run by:

*DELNV-L and/or DRDCO-COM-RM-1

Inspection and Acceptance of the Devices under SLIN 0001AC (pilot run) will be performed at the factory of the contractor by:

*DCASMA

INSPECTION AND ACCEPTANCE (Cont)

Inspection and Acceptance of SLIN 0008AA will be performed at the factory of the contractor by:

*DCASMA and/or DRDCO-COM-RM-1

Final Inspection and Acceptance of the Production Capability Demonstration, CLIN 0006, will be made at time of demonstration by:

*DELNV-L and/or DRDCO-COM-RM-1 and/or DRDCO-PC-D

Location of demonstration will be as mutually agreed by the contractor and the Contracting Officer prior to Invitation Letter issuance.

Address listings with "SHIP TO" or "MARKED FOR" data shall be used when shipping hardware or software (data) items.

For Code DELNV-L:

SHIP TO:

Property Officer, USA MERADCOM
Bldg 335
Fort Belvoir, VA 22060

MARKED FOR:

Commander
USA ERADCOM
ATTN: DELNV-L (Mr. Skeldon)
Fort Belvoir, VA 22060

For Code DRDCO-COM-RM-1:

Commander
USA CORADCOM
CENCOMS
ATTN: DRDCO-COM-RM-1 (Mr. L. Coryell)
Fort Monmouth, New Jersey

INSPECTION AND ACCEPTANCE (Cont)

For Code DRDCO-PC-D:

Commander
USA CORADCOM
Procurement Directorate
ATTN: DRDCO-PC-D (Mr. J. C. Hunter)
Fort Monmouth, New Jersey 07703

For Code DCASMA:

DCASMA, Springfield
240 Route 22
Springfield, New Jersey 07681
ATTN: DCRNGSCC-S4 (Mr. J. Martorano)
Contract DAAB07-76-C-0040"

V

PART II, THE SCHEDULE, SECTION K, CONTRACT ADMINISTRATION DATA, is amended as follows:

1. Subsection K.1 - PLACE OF PERFORMANCE, subparagraph 1, DELETE in its entirety and SUBSTITUTE the following:

"1. The work called for herein will be performed by the contractor at the following locations:

ITEM NO.	LOCATION OF	
All	Final Manufacture	New Brunswick, New Jersey 08901
	Packaging and Packing	New Brunswick, New Jersey 08901
	Shipping Point	New Brunswick, New Jersey 08901
	Producing Facilities Locations	Laser Diode Laboratories, Inc., Owner 1130 Somerset Street New Brunswick, New Jersey 08901
		105 Forrest Street Metuchen, New Jersey 08817

PLACE OF PERFORMANCE (Cont)

Contractor's office which will receive payment, supervise and administer the contract:

1130 Somerset Street
New Brunswick, New Jersey 08901"

2. Subparagraph K.2, subparagraph a., DELETE in its entirety and SUBSTITUTE the following:

"Name: John C. Hunter

Organization: USA CORADCOM
Procurement Directorate
Attn: DRDCO-PC-D(HUN)
Fort Monmouth, New Jersey 07703

Telephone No.: (201) 532-1716/3306

Autovon No.: 992-1716/3306"

VI

PART IV, SECTION M, is amended as follows:

1. DD Form 1423 Data Requirements, pages 58 through 62 revised - copies attached.

2. Add to List of Documents "Amendment 5 to SCS511, dated 23 Sep 1980" (copy attached).

VII

The consideration for this extension in delivery is the additional tasks required to fabricate CLIN 0001AD items.

VIII

PCO responsibility for this contract has changed as follows:

FROM: Stephen L. Thacher
Major, Signal Corps
DRSEL-PC-C-CS-2(THA)
Phone (201) 532-3506

TO: Joseph E. Feeney
Contracting Officer
United States of America
Phone (201) 532-1716

IX

Inclusion of the above changes shall be at no additional cost to the Government. All other terms and conditions of this contract remain unchanged and in effect.

APPENDIX C

DISTRIBUTION LIST

RCA Laboratories
David Sarnoff Research Center
Princeton, NJ 08540
ATTN: Dr. M. Ettenberg

Rockwell International
1049 Camino Dos Rios
PO Box 1085
Thousand Oaks, CA 91360
ATTN: Dr. P.D. Dapkus

TRW
Technology Research Center
2525 East El Segundo Blvd
El Segundo, CA 90245
ATTN: H.D. Law

Varian
Central Research Laboratories
611 Hansen Way
Palo Alto, CA 94303
ATTN: Dr. R. L. Bell

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San Diego, CA 92152

Lasertron, Inc
8 Alfred Circle
Bedford, MA 01730
ATTN: Dr. J.J. Hsieh

Reliability Analysis Center
ATTN: RBRAC (Mr. I. Krulac)
Griffiss AFB, NY 13441

Commander, Rome Air Development Center
ATTN: RADC/DCCT (Mr. P.Sierak)
Griffiss AFB, NY 13441

Commander
US Army Satellite Communications Agency
Fort Monmouth, NJ 07703
ATTN: DRCPM-SC-3

Commander
US Army Avionics Research and
Development Activity
ATTN: DAVAA-D
Fort Monmouth, NJ 07703

ITT Electro-Optical Products Div
7635 Plantation Road
Roanoke, VA 24019
ATTN: Mr. R. McDevitt

Hughes Aircraft Corp
Tucson Systems Engrg. Dept.
PO Box 8[illegible]
Tucson, AZ 85734
ATTN: Mr. D. Fox

Tri-Tac Office
ATTN: TT-DA (Mr. C. Arnold)
Fort Monmouth, NJ 07703

Advisory Group on Electron Devices
ATTN: Secy, Working Group D(Lasers)
201 Varick Street
New York, NY 10014

Raytheon Company
Communications Systems Directorate
Equipment Division
528 Boston Post Road
Sudbury, MA 01776
ATTN: Mr. T. Kelly

General Optronics Corp
3005 Hadley Road
South Plainfield, NJ 07080
ATTN: P.W. Hankin

Motorola, Inc.
High Frequency and Optical Products Div
5005 East McDowell Road
Phoenix, AZ 85008
ATTN: J.C. Herman

The Plessey Company, LTD
Allen Clark Research Center
Caswell, Towcester
Northants, England NN12 8EQ
ATTN: R. Davis

Commander
Naval Ocean Systems Center
Code 4400
San Diego, CA 92152
Attn: Mr. R. Lebduska

Commander
Naval Ocean Systems Center
Attn: Library
San Diego, CA 92152

Harris Government Comm Systems Div.
P.O. Box 37
Melbourne, FL 32901
Attn: Mr. R. Painter

ITT Defense Communications Division
492 River Road
Nutley, NJ 07110
Attn: Dr. P. Steensma

GTE Products Corp
Communications System Division
189 B Street
Needham Heights, MA 02194

Mitre Corp.
P.O. Box 208
Bedford, MA 01730
Attn: Mr. R. Hazel

National Bureau of Standards
Electromagnetic Tech Div
Boulder, CO 80303
Attn. Dr. G. Day

Defense Logistics Agency
Attn: DESC-EMT (Mr. A. Hudson)
Dayton, OH 45444

Commander
Naval Avionics Facility
Code D831
Indianapolis, IN 46218
Attn: Mr. R. Katz

Commander
Air Force Avionics Laboratory
Attn: AFAL/AAD-2 (Mr. K. Trumble)
Wright-PattersonAFB, OH 45433

CDR, US Army Signals Warfare Lab
Attn: DELSW-OS
Arlington Hall Station
Arlington, VA 22212

CDR, US Army Signals Warfare Lab
Attn: DELSW-AN
Arlington Hall Station
Arlington, VA 22212

Commander
US Army Logistics Center
Attn: ATCL-MC
Fort Lee, VA 23801

Commander
US Army Training & Doctrine Command
Attn: ATCD-TEC
Fort Monroe, VA 23651

Commander
US Army Training & Doctrine Command
Attn: ATCD-TM
Fort Monroe, VA 23651

NASA Scientific & Tech Info Facility
Baltimore/Washington Intl Airport
P.O. Box 8757
Baltimore, MD 21240

CDR, US Army Research Office
Attn: DRXRO-IP
P.O. Box 12211
Research Triangle Park, NC 27709

Director
N.S. Army Material Systems Analysis Actr.
Attn: DRXSY-MP
Aberdeen Proving Ground, MD 21005

Advisory Group in Electron Devices
201 Varick Street, 9th Floor
New York, NY 10014

Commander
ERADCOM
Fort Monmouth, NJ 07703
Attn: DELET-D

Commander
ERADCOM
Fort Monmouth, NJ 07703
Attn: DELSD-L-S

Commander
CECOM
Fort Monmouth, NJ 07703
Attn: DRSEL-COM-D

Commander
CECOM
Fort Monmouth, NJ 07703
Attn: DRSEL-SEI

Commander
CECOM
Fort Monmouth, NJ 07703
ATTN: DRSEL-COM-RM-1 (Mr. L. Coryell)
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Fort Huachuca, AZ 85613

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US Army Electronic Proving Ground
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USASA Test & Evaluation Center
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Command, Control & Communications Div.
Development Center
Marine Corps Development & Educ Comd
Quantico, VA 22134

Naval Telecommunications Command
Technical Library, Code 91L
4401 Massachusetts Avenue, NW
Washington, DC 20390

Rome Air Development Center
Attn: Documents Library (TILD)
Griffiss AFB, N.Y. 13441

HQDA (DAMA-ARP/DR. F.D. Verderame)
Washington, DC 20310

Director
US Army Human Engineering Labs
Aberdeen Proving Ground, MD 21005

CDR, AVRADCOM
Attn: DRSAV-E
P.O. Box 209
St. Louis, MO 63166

Director
Joint Comm Office (TRI-TAC)
Attn: TT-AD (Tech Docu Cen)
Fort Monmouth, NJ 07703

Dir.,US Army Air Mobility R&D Lab
Attn: T. Cossett, Bldg. 207-5
NASA Ames Research Center
Moffett Field, CA 94035

HQDA (DAMO-TCE)
Washington, DC 20310

Deputy for Science & Technology
Office, Asst Sec Army (R&D)
Washington, DC 20310

Commander, DARCOM
Attn: DRCDE
5001 Eisenhower Avenue
Alexandria, VA 22333

END

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